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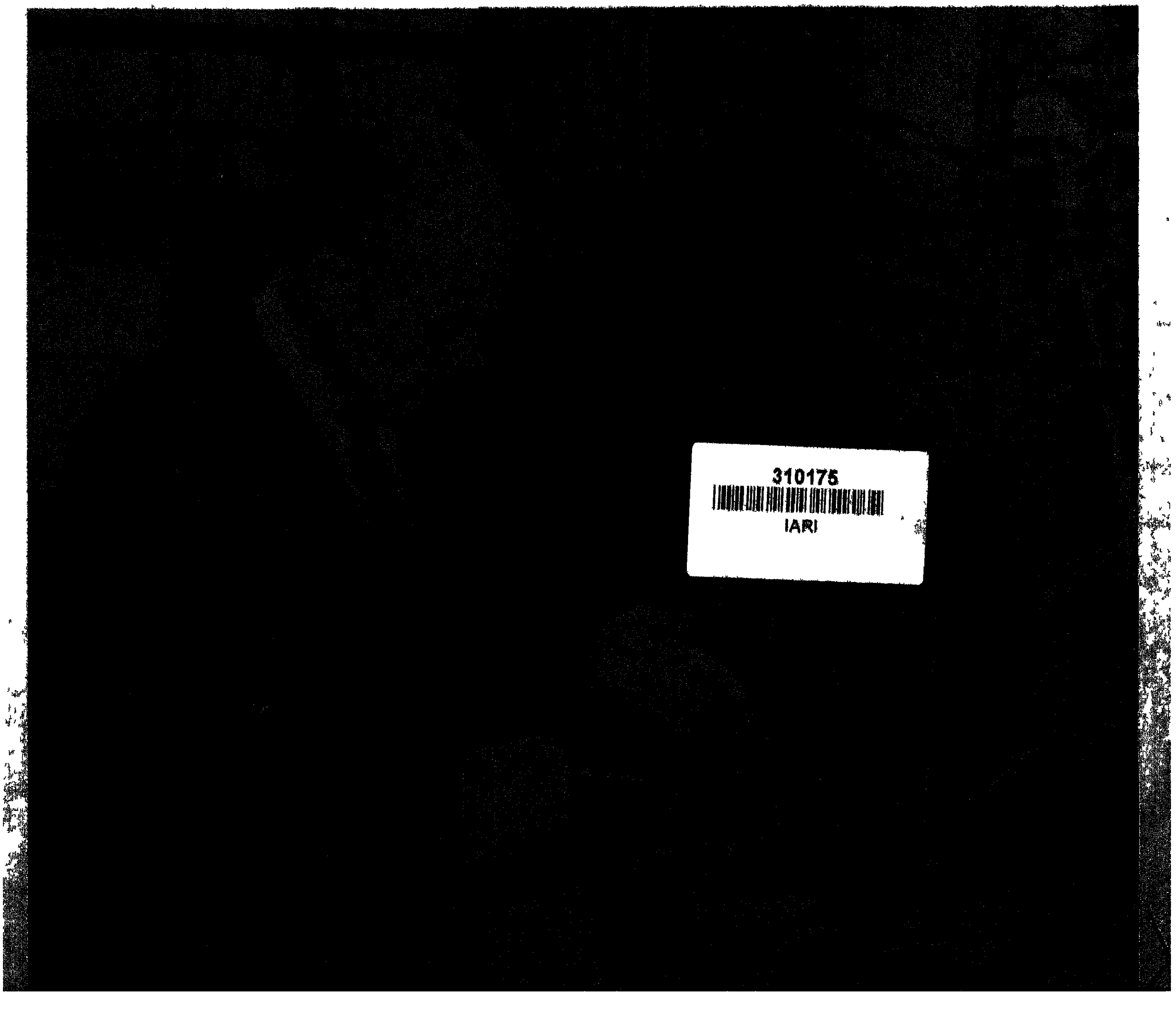
FEBRUARY, 1971

16

Focus on Michigan's Bean Industry



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Michigan's Bean Industry

Michigan State University scientists doing work involving the bean industry represent a wide range of specialty areas and university departments. Some of these are listed below:

Breeding and varietal development — M. Wayne Adams, Crop and Soil Sciences
Blight and bactericides — A. W. Saettler, Botany and Plant Pathology
Herbicides and weed control — William F. Meggitt, Crop and Soil Sciences
Diseases — Axel L. Andersen, Botany and Plant Pathology
Harvesting — Leroy K. Pickett, Agricultural Engineering
Cultural practices — Milton H. Erdmann, Crop and Soil Sciences
Food processing — Clifford L. Bedford, Food Science
Marketing — Marvin L. Hayenga, Agricultural Economics
Proteins and nutrition — Robert J. Evans, Biochemistry
Nematodes and soil insects — Arthur L. Wells, Entomology

Michigan ranks first in dry field bean production with about 40 percent of the total United States production. Research efforts by Michigan State University agricultural scientists have helped make Michigan the nation's largest producer.

Research areas include crop and soil sciences, plant pathology, food science, entomology, biochemistry and agricultural engineering.

Cover: Dr. M. Wayne Adams checks blight infection in greenhouse plants. Screening tests for blights aid the search for blight-resistant bean varieties.

New Varieties

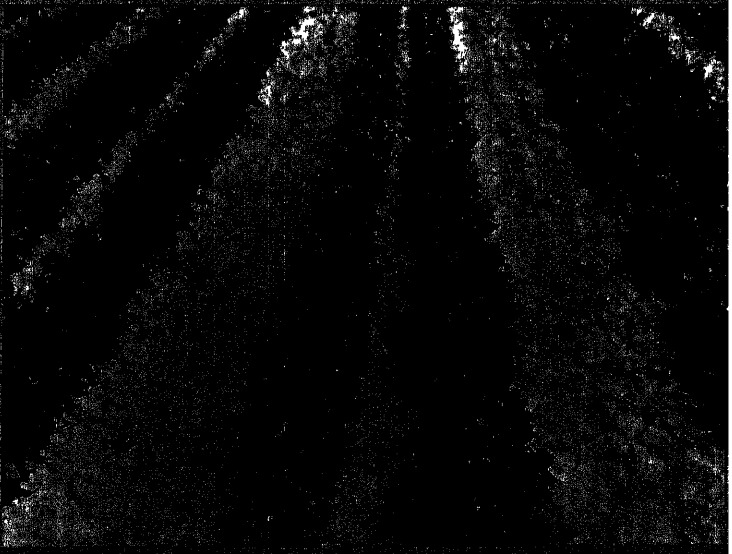
In the 1914-19 period, 474,000 acres of beans yielded 530 pounds per acre. By 1940-42, the acreage had reached 606,000 and the yield per acre 850 pounds. By the 1964-67 period, the yield on 600,000 acres averaged 1,130 pounds per acre.

This increase in yield and quality has been accomplished over the years through the release of new and improved varieties and with improved fertilization practices. Robust was the first virus-resistant variety; Michelite maintained this virus resistance and added improved quality; Sanilac was the first upright or bush type bean plant; Seaway, Seafarer and Gratiot added earliness and more disease resistance; Charlevoix was the first early dark red, anthracnose-resistant variety; Manitou was a light red anthracnose-resistant variety. These varieties are grown on approximately 80 percent of the bean acreage in Michigan and Ontario, Canada, and to a lesser extent, in New York State, Chile, Australia and Hungary.

The Sanilac Navy bean, released in 1956 for commercial production, was the first commercial variety released in the United States in which radiation mutation played an important part in its development. The mutant used in the crossing program was a small, early maturing, disease-susceptible bush plant which was first backcrossed to the parent, Michelite. Then the backcross derivatives were outcrossed to unrelated lines for disease resistance. The bush form and early maturity were always maintained by selection. From breeder populations of this source have come not only Sanilac, but Seaway (1960), Gratiot (1962) and Seafarer (1967).

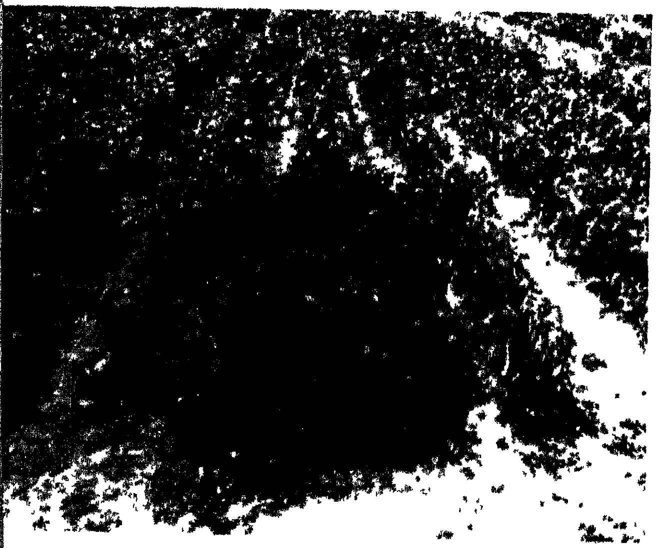
As a result, losses from weather damage, white mold, anthracnose and common bean mosaic have been virtually eliminated. The resulting production of Navy beans in Michigan doubled within a few years, bringing millions of dollars of additional revenue to Michigan farmers. Furthermore, many of the new varieties are adaptable for production in other countries and are now being grown in Canada, Australia, South Africa, South America, parts of Europe.

New early maturing bush [illegible] ready to be [illegible] with added [illegible] improved [illegible] disease [illegible]



Halo Bacterial Blight Disease Breeding

Halo blight is transmitted naturally by infected seed. Because of the high cost of chemical spraying to control the disease, breeding resistant varieties is the most efficient means of eliminating halo blight. MSU plant breeders and plant pathologists are developing light and dark red kidney beans tolerant to the disease. They hope to release new varieties for Michigan growers soon.



Halo, common and fuscous bacterial blights have all but killed the bean plants surrounding this extremely tolerant selection. The healthy, green leaves and vigorous plant growth of this selection indicate genetic resistance to disease.

Although this selection possesses resistance to bacterial diseases, it is a vine-type plant, late-maturing and of poor seed type and quality. Several years of research will be required to transfer this resistance to Michigan's field bean types.

Breeding for Damage Resistance

Mechanical damage to dry beans caused by harvesting, cleaning, and handling equipment has become an aggravating and costly problem in recent years.

Damage in individual lots has varied from 1-2 percent up to, in one case, 18 percent. Buyers often reject shipments containing 3 percent or more split and checked beans. Financial losses to grower and shipper amount to many thousands of dollars annually.

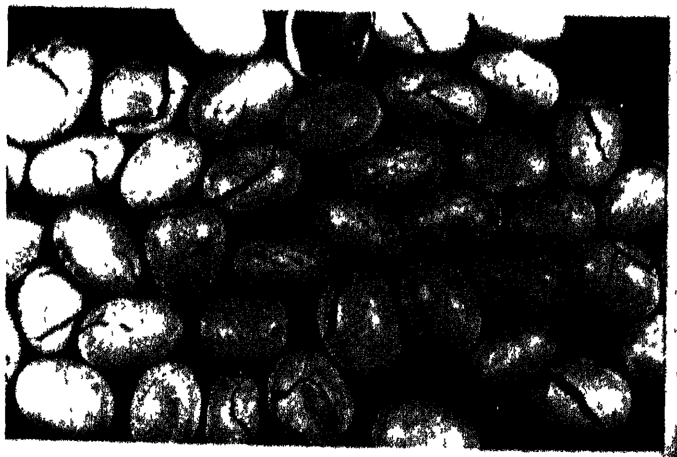
Researchers at MSU are seeking new, damage-resistant varieties and are experimenting with new machines and new processes that allow the bean to retain its wholeness and firmness when canned.

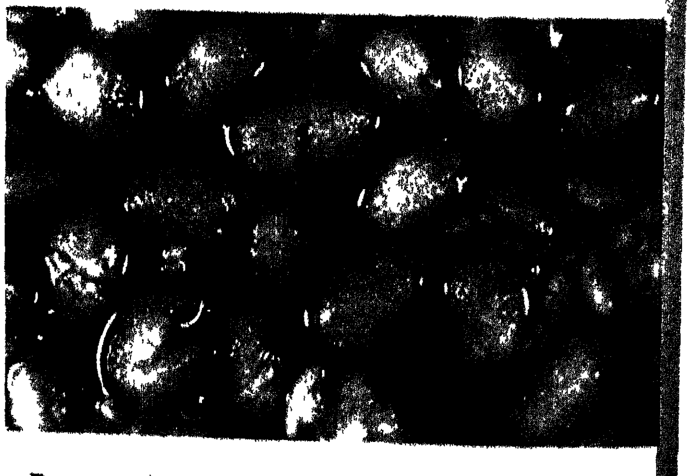
Breeding for Direct Harvest

MSU scientists hope to direct-harvest beans. This depends on:

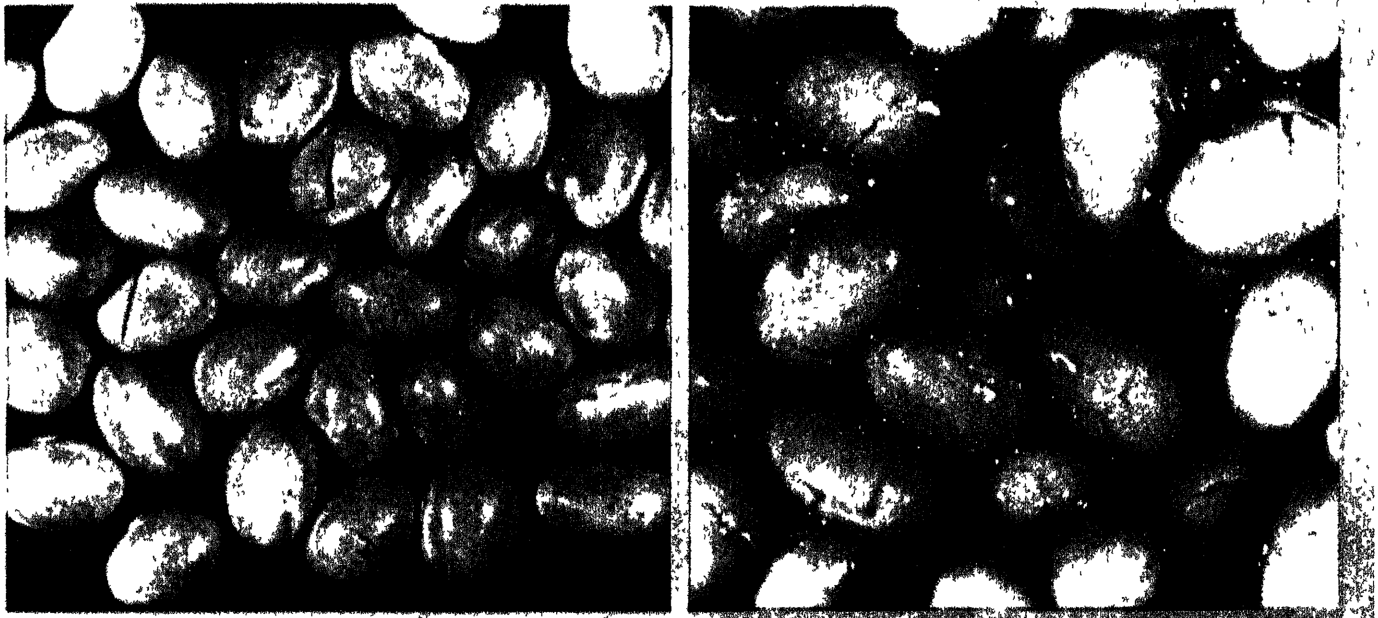
1. modification of the plant so that bean pods are borne at higher levels on the plant stem.
2. herbicides and cultural practices so effective in weed control that it will no longer be required to throw soil around the base of the plant in cultivation operations.
3. modification of the combine so as to cut the plant near ground with a "free-floating" sickle bar that follows slight undulations in soil surface.

The result of direct harvesting of beans will be to lower harvesting costs and have a brighter, cleaner product that will be more acceptable to the processor.

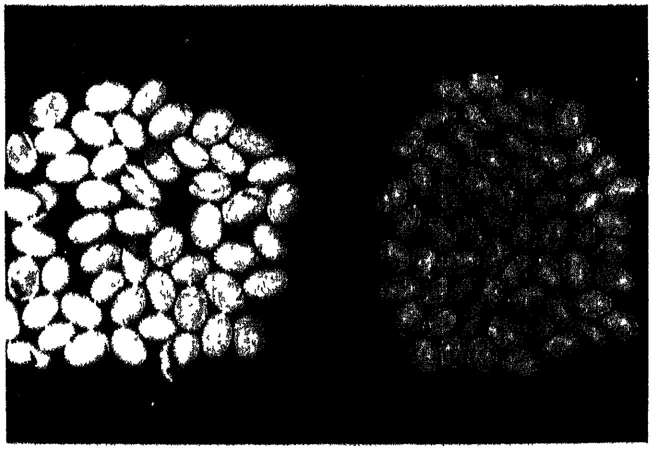




Beans with a high percentage of splits, chips and checked seed coats make a poor product when canned.

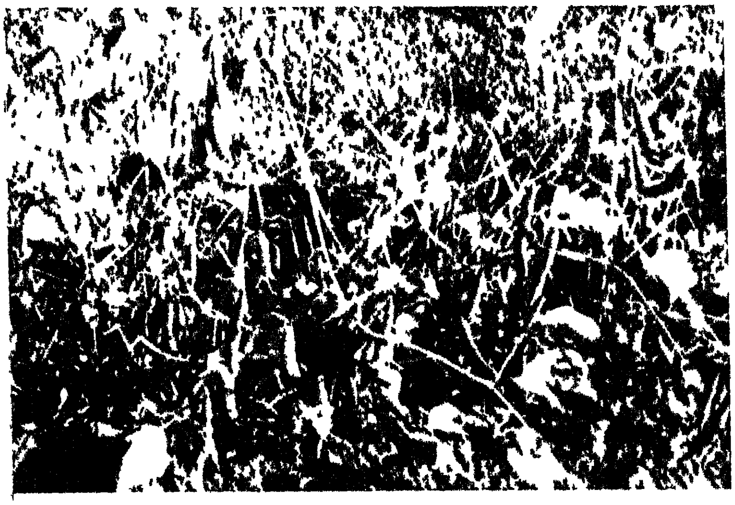


Beans with only slight damage result in a canned product that is bright and attractive.



Strains of beans differ in their sensitivity to mechanical damage. Both of these samples were at the same moisture level (13%) and were mechanically abused in a test machine.

Plant breeders hope to incorporate this elongated hypocotyl trait into new varieties.



These plants were severely infected with common and fuscous blight. Note the premature leaf drop before pods have matured. Most of these pods will not produce marketable beans. Blight not only cuts yield, but also affects bean quality.

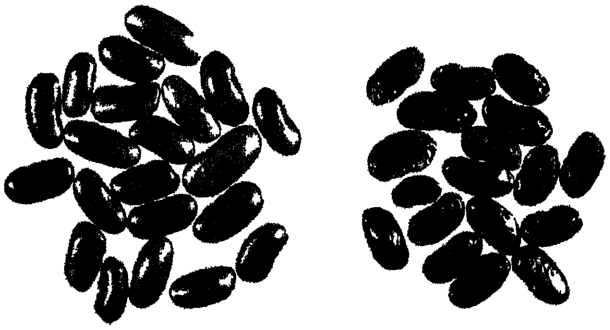
Common and Fuscous Blight Diseases

Common and fuscous bacterial blight diseases are found on all commercially grown varieties of beans, but are particularly damaging to Michigan's Navy beans. In 1969, at least 500,000 of Michigan's 650,000 acres of Navy beans were damaged by bacterial blight. Yield reductions of 10-20 percent were common; in some fields, yields were reduced almost 50 percent.

Yield reductions alone account for a $5-10,000 loss to Michigan farmers. There is further monetary loss resulting from the decreased quality of the bean due to forced, premature ripening.

The bacteria are able to survive for 30 or more years in the seed. No chemical seed treatment has yet been effective in killing the bacteria under the seed coat, nor have chemical sprays been effective in controlling the diseases in the field. Sources of genetic tolerance to both diseases have been found and MSU researchers are trying to transfer this resistance to Michigan Navy bean varieties.

These navy beans are infected with common and fuscous bacterial diseases. The brown spots and dying leaves are the characteristic symptoms for these blights. Early infection interferes with the ability of leaves to sustain pod development. Note the small, flat pods which do not contain beans.



Charlevoix dark red kidney bean seeds infected with halo blight (right) and healthy seeds (left).

The dark, small seed has become infected by halo blight. Seeds such as this one, planted the following season, are responsible for severe disease outbreaks.

Bean Blight Testing

To help bean growers select a good seed for planting, MSU plant scientists have developed a testing program to detect blight infected seed.

The MSU Plant Disease Diagnostic Laboratory conducts the testing service. This service includes the use of serological and plant injection tests for detecting common and fuscous bacterial blight on and in the bean seed.

After the seed has been determined free from blight organisms, the MSU scientists recommend treating with a slurry containing a bactericide, an insecticide and a fungicide. This treatment prevents blight-free beans from becoming contaminated during processing and handling in elevators, trucks, farm sheds and planters.

According to scientists, these are just the first steps that must be taken to reduce bacterial blight contamination on Michigan farms.

The dark and light red kidney, cranberry and yelloweye dry bean varieties constitute a relatively small, but significant part of field bean production in Michigan. In 1968, Michigan bean growers produced 26% or 305,000-100 lb. bags of the red kidney, 96% or 155,000-100 lb. bags of the cranberry, and 100% or 40,000-100 lb. bags of the yelloweye beans grown in the United States.

Recent improvements in fertilizer, pesticides and seed technologies have resulted in better yields and better seed quality. However, a gradual increase in halo bacterial blight is threatening colored bean production in Michigan.

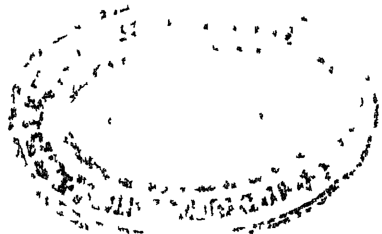
Four years of field experiments by plant pathologists at MSU have shown that proper and timely applications of copper-containing chemical sprays will control halo bacterial blight. Scientists also found aerial application of the sprays superior to ground application.

Timing applications for halo blight control depends primarily upon the amount of disease initially detected and the subsequent potential for disease spread, according to research results.

The experiments showed that the addition of an agricultural oil to a reduced amount of copper material provided control as good as the material alone.

Research indicates that copper sprays for halo blight may or may not increase yield, but the sprays generally have a beneficial effect on seed quality.

This kidney bean pod is infected with halo bacterial blight. Note the masses of white bacteria on pod surface.

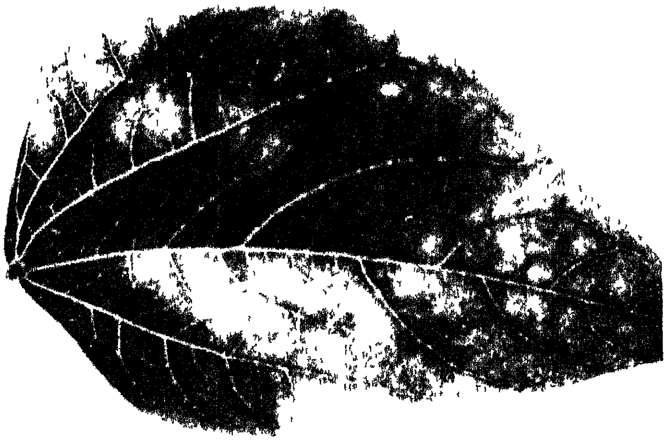


Aerial application of copper-containing sprays has provided effective control of halo blight on beans in test plots.

Several management operations help control blight MSU scientists found these practices effective:

1. Practice a longer rotation of crops A rotation of beans-corn-wheat-legume is excellent, and in sugar beet areas a 3-year bean-corn-beet rotation is good.
2. If longer rotation is not possible, use deep plowing to bury all refuse deeply.
3. Sanitize equipment and storage facilities to eliminate blight contamination.
4. Isolate fields as much as possible, plant in smaller units and separate with corn strips, if possible.
5. Treat all bean seed with a slurry containing a bactericide, a fungicide and an insecticide
6. Have a good herbicide program Getting rid of weeds early is a help in reducing cultivation and activity within a bean field Don't work in bean fields while the plants are wet.
7. Be alert to infection.

One infected seed was responsible for this circular infection by halo blight.



This kidney bean leaf is infected with halo blight. Light areas (halos) surround points of infection.

Weak plants with poor root systems result when root rot infects beans early. The large circular spots indicate where standing water or some other stress has aggravated root rot.

Red lesions (spots) on roots are symptoms of the root rot fungus. Such spots often merge to cover the entire root eliminating the ability of the root to function normally.

Bean root rot, caused by fungi living in the soil, is found in all areas of Michigan. Infection by this disease decreases the ability of the root system to function normally to support plant growth. Poor plant stands, weak root systems and dry weather then act together to reduce yields and hasten premature defoliation. Ordinarily, losses are high only when the disease is combined with dry weather. A conservative estimate of dollar loss due to root rot is $1,500,000 annually in Michigan.

MSU scientists believe that selective crop rotation, soil fertility, and chemical treatments, combined with a breeding program to increase resistance to this disease, hold the most promise for preventing root rot losses.

MSU researchers studied the relationship of soil microorganisms' ecology to the development of bean root rot under various cropping sequences. This research related a bacterium parasitizing a root rotting fungus to disease severity.

When beans were planted in the field where corn had been grown, root rot was much less severe. When beans followed other crops, this was not so. Furthermore, bacterial parasitism of the root rot fungus was higher in beans planted after corn than in beans following other crops.

In this section of a bean field infested with perennial sow thistle, the yield of beans is practically zero.

This shows leaf feeding on beans by the green clover worm which quite suddenly in 1965 became a widespread pest in Michigan's bean area. It has since subsided and does not at this time constitute a serious menace.

Herbicides that are effective against annual weeds are ineffective against long-lived perennial weeds.

In many situations, these hard-to-kill perennials are now the most serious weed pest of the east-central Michigan cash crop region. Weed eradication by repeated tillage or by hand is costly. Often, it cannot be done in time to prevent serious losses in productivity of the crop. Control systems that are effective against perennial weeds, compatible with major cash crops and that are safe to use and reasonable in cost are needed. Researchers are looking for these control systems.

Certain experimental nematocides reduce nematode populations and provide foliar insect control on field beans.

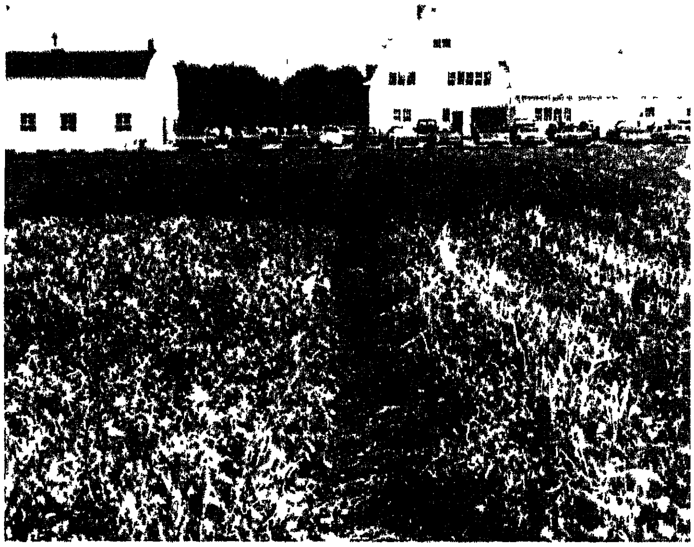
The role of annual nematode control by fumigation is being researched by MSU entomologists. Early results indicate that spring fumigation under Michigan conditions can cause poor germination in crops and uneven stands, even with a normal waiting period before planting. Fall fumigation eliminates this risk. However, dry beans were not adversely affected by the spring fumigations.

Economic justification of nematode control by fumigation in cash crops on upland soil is unclear. Effects and benefits in succeeding growing seasons need to be evaluated. High value crops must be grown to justify the expense of fumigation at the present time. Soil applications of granular nematocides could reduce expenses.

Evaluation of new compounds, application techniques, rates and times of application is continuing at MSU. Effects of nematode control in cash crop rotations will be studied more thoroughly with different varieties and plant populations.

Doublecropping

One way to get greater returns per acre is to grow more than one crop per year — doublecropping MSU scientists researched this management practice, still more research is required on tillage, stand establishment, weed control, and machine modification.



In this doublecropping research, winter barley was harvested on July 2 yielding 90 bushels per acre. On July 3, early maturing navy beans (foreground) and soybeans (background) were planted on plowing (left) and in barley stubble (right). Yields averaged over 32 bushels per acre for field beans and 36 bushels per acre for the soybeans.

Crop Rotation Effects

Field crops are grown in sequences. A fertilization practice or a cultural practice used on a crop will often adversely affect the following crop.

Frequently, a new process or chemical is introduced into a cropping system for a specific purpose on a specific crop. Possible adverse effects on other crops in the system are not considered.

MSU scientists have found that changes in technological inputs or practices must be considered in systems. They must not be thought of as isolated inputs, since the goal is to maximize returns from the entire crop production system, not just one part of the system.

Bean Nutrient Research

Bean varieties differ in their ability to function normally under conditions of nutrient imbalance. This ability is controlled genetically. Varieties can be bred with greater nutrient uptake capacity.

Soils also differ in their ability to supply nutrients at rates which promote rapid plant growth and high yields. Fertilizer practices must take both the soil and the plant into consideration.

For example, when available zinc levels in the high alkaline, heavy soils of the Saginaw Valley became low due to a combination of previous plant uptake and heavy phosphate fertilization, the effect was seen most severely in beans. MSU crop scientists discovered that the most widely grown bean variety in that region was also the most sensitive to low levels of zinc.

MSU crop and soil scientists plan research to determine the influence of changing nutrient balances on maturity, quality and mineral nutrition of beans. More specifically, the scientists will study the influence of changing nutrient balances in the soil on:

a. uniformity and time of maturity and the subsequent storage, canning, flavor, color and nutritional quality of beans harvested at different stages of maturity.

b. concentration of potential quality influencing micronutrients in the beans at various stages of maturity.

c. protein quality as determined by methionine content in bean protein.

They will also determine the influence of changing nutrient balances in the soil on yield and nutrient composition of bean plants.

Boron Toxicity in Beans

Planned research will relate plant tissue and soil test levels of boron to crop toxicity and yields. Also, MSU scientists will determine by soil test methods the current levels of boron in selected Michigan soils of agricultural importance.

Research shows that on zinc-deficient soils, the genetic differences of bean plants affect their ability to uptake, transport and use mineral nutrients.

Research on use of light reflection in soybeans suggests that plants in dense plantings may suffer from light deficiency. Plant form and planting patterns need to be evaluated to gain higher efficiency in utilization of sunlight.

Harvesting losses are high for field beans. This is caused by high gathering losses. Normally, several field operations are used for gathering, including pulling with a blade-type tillage tool, windrowing with a bean windrower or side-delivery rake, and picking up the windrows with a combine With present practices, total gathering losses of from 5 to 12 percent may be expected for normal weather conditions. Gathering losses are usually increased by bad weather conditions and an extended harvest period.

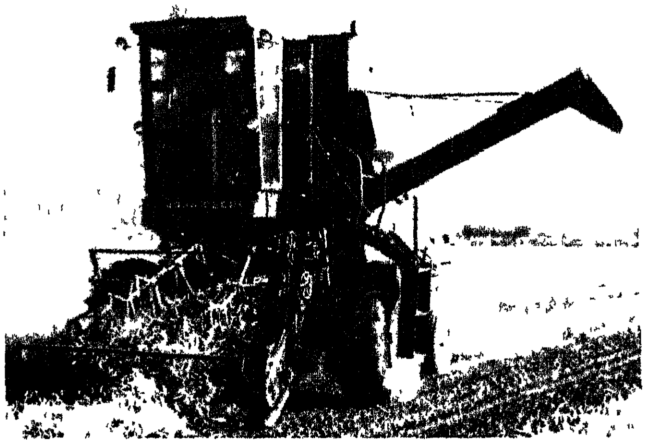
Aware of high losses associated with bean harvesting, MSU researchers conducted studies in the early 1950s to facilitate direct harvesting of beans. A high speed rotary saw was used to cut the beans and lacerate the stem to speed drying and speed the harvesting operations The beans could not be directly harvested behind the cutter because they were too viny. Today, with the development of new bean varieties and the acceptance of the bush-type beans, there is new interest in direct harvesting methods.

In 1967, the researchers began development of a slower speed twin-disk rotary cutter. The cutting disks were operated at a slower speed because the smaller stem of the bush-type bean did not have to be lacerated for drying purposes. The second disk operating against the first one at the cutting edge eliminated the need for high disk speed. The slower speed allowed more delicate handling with less bean shatter loss. Methods of conveying the cut beans from the twin-disk cutting mechanism to the threshing device needs more research.

Research to determine the best way for completing the harvesting operation in one pass over the field is being continued. Direct cutting methods including various rotating-disk arrangements, a flexible sickle bar, reciprocating blades along with suitable conveying mechanisms are being studied.

In recent years, bean processing firms have indicated a growing concern over the physical quality of beans. As a result, MSU scientists are evaluating the quality of beans as influenced by the harvesting operation. They believe that much of the mechanical damage to beans may be caused by high impact loads during threshing. However, the effect of other devices such as conveying and cleaning mechanisms which are part of harvesting machines are also being studied. With identification of bean damage sources, corrective measures can be taken to provide high quality beans for the processor and maximum selling price for the farmer.

Deterioration of navy bean quality will be studied by MSU scientists. In addition, the relationships between seed moisture, relative humidity and temperature for beans grown under selected environmental conditions will be determined. The results will be the basis for further study of moisture transfer problems during the shipment of beans in bags, as well as in closed containers.



Normal harvesting losses of 5 to 12 percent may be reduced by direct harvesting of field beans. MSU scientists are developing a one-pass harvesting system and working to reduce mechanical damage to beans during the harvesting process.

Drying Methods For Bean Powder Production

Instant precooked bean powder eliminates the soaking and cooking requirements. This product may help reverse the decline in per capita consumption of dry beans.

An instant bean powder must reconstitute rapidly to the same texture, appearance and taste as a conventionally prepared bean soup Only powders in which cell rupture has been kept to an absolute minimum meet this requirement. If too many cells are broken and too much free starch is liberated, the reconstitute product will be pasty and unacceptable For this reason instant bean powder cannot be made by dry milling whole precooked dried beans.

Instant precooked bean powder is made by a process in which the beans are soaked, cooked and dried The moisture content of the cooked beans is between 50 and 55 percent, wet basis.

Drum and spray drying are the most economical drying methods for the removal of excess moisture from high moisture content food slurries These two processes for making instant bean powder with good flavor and reconstitution characteristics were evaluated by MSU scientists.

Although it is possible to produce acceptable bean powders with either drum or spray drying, a single-drum dryer is better. The cooked beans do not have to be pureed with a drum dryer and the final product has higher quality, according to research results.

Proteins Of Dry Beans

Nutritional research with dry beans at Michigan State University has centered around the proteins of dry beans. Protein research can be divided into three areas:

1. Methods of extraction and precipitation of proteins from dried beans.
2. The nutritive value of navy bean proteins.
3. Growth inhibition of rats fed raw navy beans and the action of antibiotics in overcoming it.

Measuring a Key Protein

A new technique for measuring a key protein "building block" may make beans a significant item in the world's future food diet.

Beans are a significant protein source for many of the under-developed areas of the world. However, beans have some unusual characteristics that decrease their value when compared to other protein sources such as meat and fish.

MSU researchers are particularly concerned with methionine — an amino acid and a key protein building block vital to human nutrition. Without methionine, the body can live but it cannot grow. Methionine, although present in beans and other legumes, is not there in sufficient amounts to promote good nutrition.

Scientists want to find a better way to determine the amount of methionine present in various varieties of beans. Their methods would be used to select parent plants for use in breeding new bean varieties with a higher methionine content.

Such high-protein hybrids could have a great impact on food problems in areas like India, Mexico and South America, where large portions of the population depend on beans as their major source of protein.

Geneticists want to screen thousands of bean varieties before they start their breeding program. That's why a new protein analysis method is needed. Other methods of analysis take too long to be of value to this study.

Researchers plan protein and amino acid analysis by micro-biological assay. This procedure utilizes the growth of tiny life forms, bacteria, invisible to the naked eye, as indicators of amounts of methionine in samples.

Not only could this research be of great importance to nations where protein sources are limited, but it may be a critical factor in the nutritional problems faced by the world of the future.

Bean Products

MSU agricultural economists point out that navy beans are only 30-40 percent of all dry beans produced in the United States. The characteristics of other dry beans are so different from navy beans that only one kind — California small white — can be considered at all substitutable in the canning industry, the major market for navy beans. While other dry beans are less readily substitutable for canning, they appear to be readily substituted by housewives in the fairly small packaged dry bean market. Packaged this way, further processing cooking, seasoning and addition of other ingredients are left for the housewife. Thus, the importance of some product characteristics varies between the canning and the packaged dry bean market.

About 85-90 percent of beans destined for domestic consumption are canned with the remainder being packaged and sold as dry beans. Canned beans of many types can be found on the grocery shelves. The most important bean product in the United States is pork and beans; this product represent 80-85 percent of total canner sales. Eighty to 90 percent of the pork and beans volume is marketed in consumer size cans while the remainder is destined for the institutional trade. Other navy bean products sold in the United States include vegetarian beans (beans in tomato sauce, no meat), beans and ground beef, beans and weiners, beans and Vienna sausages, bean with bacon soup, and the traditional old-style products such as beans with molasses, baked beans and similar products.

Supply and Price

The navy bean industry is characterized by substantial production and price fluctuations from season to season. While the grower price often fluctuates sharply during a marketing season, the retail prices of the canned bean products have been changed very few times over the last several years.

Because bean production is concentrated in the Saginaw Valley and thumb areas of Michigan, weather abnormalties in a small area can cause large fluctuations in total navy bean production. A hailstorm in Saginaw County could eliminate a large share of Michigan's potential bean crop for one year.

MSU research indicates navy bean acreage is relatively stable from year-to-year. Recently compiled data suggests this may be due to the current government price support program which puts an effective bottom limit on the market price. However, the role of beans in crop rotations, habit and other factors may also contribute to acreage stability.

The domestic demand for navy beans is quite inelastic with demand growing only slightly faster than population. Also, there is a low influence of small, white bean price on navy bean domestic demand. This suggests that substantial increases in price would result from small decreases in supply, note researchers.

A simulation model recently developed at MSU provides equations that can be used for prediction purposes. Given the acreage planted the previous year, the price of navy beans and of corn for the previous year, an estimated acreage planted for the current year can be obtained. Using estimates of production, price and domestic demand, an export demand estimate can be obtained, also.

Computer simulation suggests that the government price support program has been effective in maintaining producer price above what it would have been. Also, simulation suggests that only a slight reduction in the government price support levels would have significantly diminished producer income and government expenditures in the navy bean price support program.

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This is the Sixteenth in a series of "Michigan Science in Action" publications aimed at relating the research developments in specific areas within Michigan State University's Agricultural Experiment Station.

Others in this series may be received by writing to the MSU Bulletin Office, P. O. Box 231, East Lansing, Michigan 48823.

2 — Sod and Turf — Michigan's $350 Million Carpet
4 — Focus on the Family
5 — Reshaping the Soil
6 — Focus on Beef Cattle
7 — Bedding Plants: Michigan's Blooming Industry
8 — Scientific Achievements: 1888-1969
9 — Focus on Dairy Nutrition
10 — The Bountiful Business of Bees
11 — Focus on Forestry
12 — "Tailor-Made" Vegetables
13 — Focus on Cattle Infertility
14 — Concentrate on Consumers — Mastering the Markets Serving Us
15 — Biological Control Story

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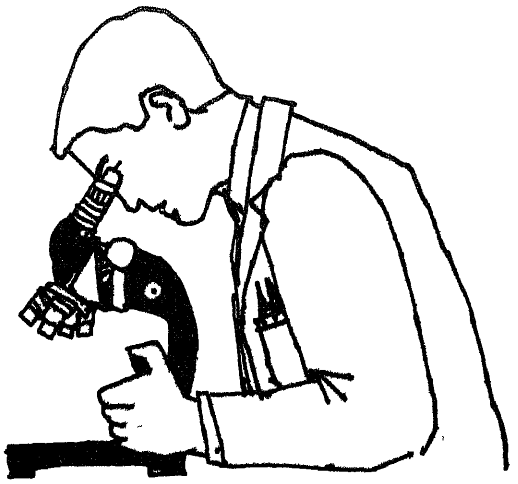
IN ACTION
FROM THE MICHIGAN STATE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION, EAST LANSING
MARCH 1971, REPRINTED MAY 1971



Developing Dwarf Apple Trees

This is the seventeenth in a series of "Michigan Science in Action" publications aimed at relating research developments to specific areas within Michigan State University's Agricultural Experiment Station.

In this publication we have tried to briefly summarize the latest research information on *dwarf apple tree development.*

Our special appreciation goes to the Dwarf Fruit Tree Association for support of this publication.

Further information is available from these sources:

- Dr. Robert F. Carlson, Dept. of Horticulture, Michigan State University
- Michigan State University Extension Bulletin–578, "Dwarfed Apple Trees."
- Michigan State University Department of Horticulture Report Series, No. 1 "Fruit Trees, Dwarfing and Propagation." 1966 (Revised February 1971)

COVER – Dr. R. F. Carlson, Michigan State University horticulturist, checks four-year-old dwarf Red Delicious tree and fruits produced by other dwarf trees in MSU's orchard.

Developing Dwarf Apple Trees

The Dwarf "Giants"

Dwarf apple trees are the "giants" of fruit industry, though their height is often only one third the size of standard trees. Yet they produce more and better quality fruit per acre.

Dwarf trees produce less fruit per tree than standard types, but they start bearing 4 to 8 years sooner, depending on the variety, rootstock and management Growers can plant up to 1,000 trees per acre. A mature apple orchard (over 10 years) will generally yield 400 to 1,000 bushels per acre, but yields recorded in Michigan State's Dwarf Tree Orchards have reached 900 bushels with Jonathan and 1,300 with Golden Delicious apple trees only 6 years old!

A larger proportion of fruit bearing area is exposed to sunlight because these trees are smaller. Thus, fruit is larger and the color superior to standard trees on dwarf types of any age. But this will not be true if trees are poorly managed.

The Beginning

Compact or dwarf trees were first found in Europe and the Orient. When scientists learned the dwarfing characteristic was caused by the trees' rootstocks, they began to collect these to produce compact trees.

Much of the early research was conducted at the East Malling Research Station, Kent, England. From 1912 to 1918 this station classified and described rootstocks, giving them numbers (EM VI, EM VII) for easy identification. Classified rootstocks are "clones" that are vegetatively propagated, not seed produced. Clones are uniform and all trees of a certain variety produced on a specific rootstock clone are uniform, too. There were 16 clones in the first classification series, producing trees ⅓ to ¾ the size of standard types.

In the 1930's the East Malling Research Station released the Malling Merten (MM) rootstock series for apples. These hybrids were developed through a breeding program to add insect resistance, better root anchorage, early fruiting and greater production.

Four-year-old spur Red Delicious on EM 26. Growers can plant 1,000 of these per acre.

Why Dwarfs?

The Move to Dwarfs

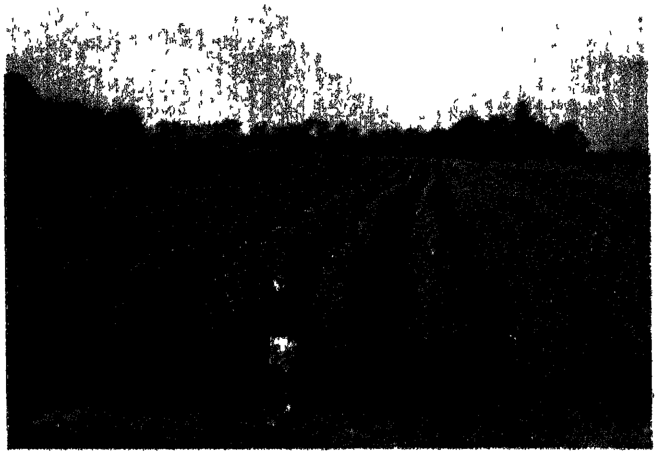
Michigan State University has been involved in developing smaller compact fruit trees for 25 years. Dr. Robert F. Carlson, MSU horticulturist, is one of very few men who devotes full time to the study and propagation of these trees.

There are sound reasons for this research emphasis:

–Michigan is a leading fruit growing state.

–Movement is toward mechanical harvesting.

–Dwarf fruit trees, not much taller than a man, are more easily picked. Eventually, these trees may be planted in almost a solid mass and harvested quickly and efficiently by machines that can move over the top of the trees.



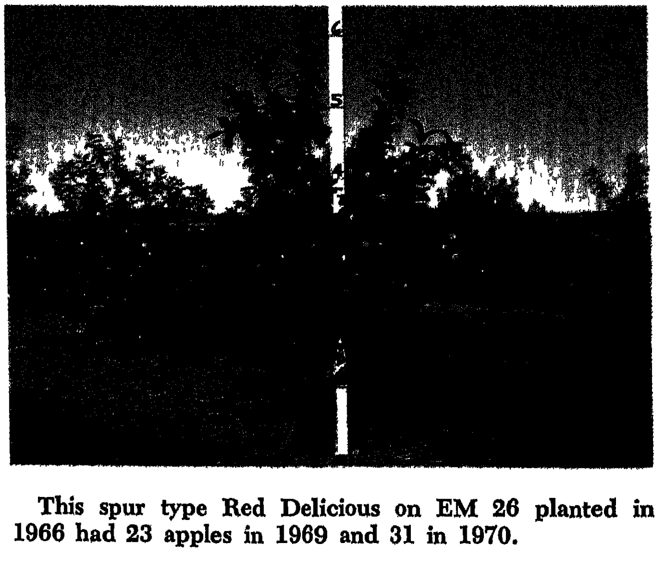
Trees in nursery budded in August and grown one season. The Golden Delicious (left) are on MM 106 and the Jonathans are on EM II.

More Trees Per Acre

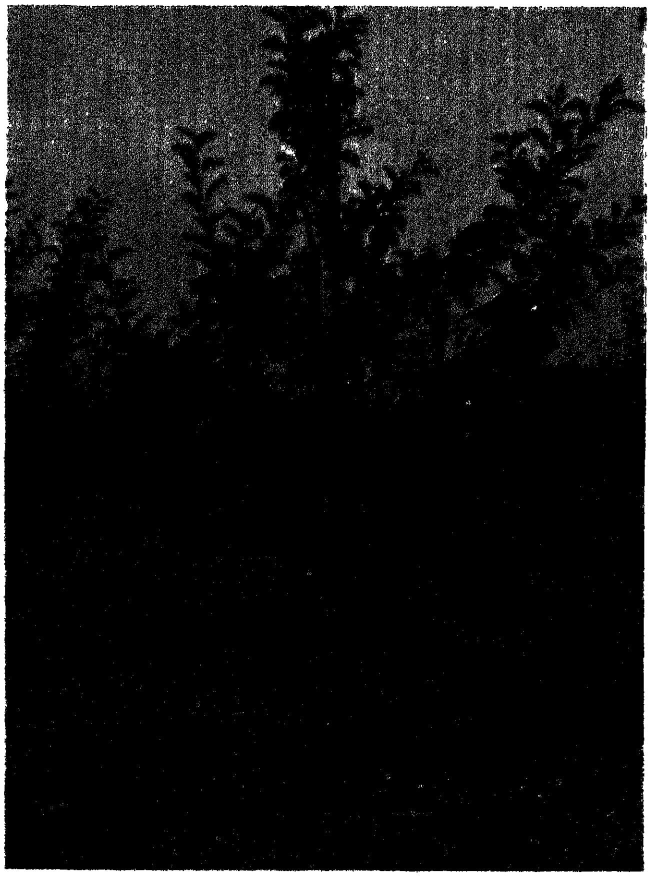
High density planting is important so more fruit can be produced on each acre. The number of trees per acre a grower wants depends on his management operation. During the next ten years, tree populations will fall in the following ranges: (1) high density plantings containing 600 to 1,000 trees per acre; (2) medium density, 300 to 600; and (3) low density, less than 300 trees per acre.

The preferred density depends on the orchard site, the grower's preference, his knowledge of handling large numbers of trees per acre, the amount of management put into the orchard and the method of harvesting. The rootstocks best suited to the different densities are outlined on pages 9-13.

Low and medium density plantings are considered more efficient and economical to manage But with further size control, mechanical harvesting aids and special "know how", more growers will consider higher density orchards. This will require more work and management skill, but will result in greater yields and income per acre.



This spur type Red Delicious on EM 26 planted in 1966 had 23 apples in 1969 and 31 in 1970.



Red Delicious trees require a central leader training system with outward spreading of selected branches. A post near the trunk gives tree support and aid for tying down lateral branches.

Easy Management

Dwarf trees, correctly propagated, are easier to manage. A 6 or 8 ft tree requires only a minimum of training and pruning and can be efficiently harvested.

If the variety is budded to a seedling rootstock, the tree will not bear fruit until it is 6 to 8 years old. This makes pruning and maintenance difficult in high density planting

Single, free standing, spindle type training is very economical. With the most dwarfing rootstocks (EM IX and EM 26) a single stake or post next to the central leader helps train the tree, but adds to initial cost. Trellising trees on two or three wires (as in grape growing) requires special care, is inconvenient and adds to management chores and cost.

Early Bearing

Dwarf fruit trees generally bear earlier than standard varieties. For example, Northern Spy bears fruit five years after it is budded on MM 106 and EM II But the standard Northern Spy may require 10 to 12 years to bear fruit

Early fruiting — the same year as planting — is not unusual when a variety is budded on EM IX or EM 26. First year fruits are usually removed from the entire tree or at least taken off the top of the central leader to keep the tree from bending and becoming misformed. This is Lodi on EM IX.

How a Dwarf Tree is Produced

Scientists begin by selecting trees that show dwarfing characteristics. Then they follow these procedures.

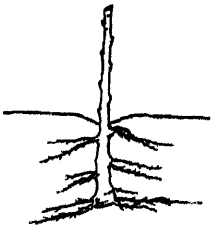
Step One A root or branch cutting is taken from the non-grafted tree showing a dwarfing characteristic. This cutting (clone) is made to root and planted in a propagation bed in the spring.

Step Two Shoots and branches grow on the clone during the first growing season. The next Spring, one year after planting, the top growth of the dwarfing rootstock is cut off at ground level causing shoots to develop below the cut.

Step Three When these new shoots are about 12 in. tall and still tender and succulent, the ground is mounded around them 6 in. high. They are mounded again in July so the final mound is about 12 to 15 in. high in the center of the row.

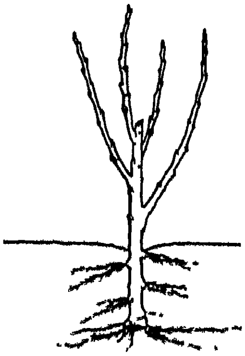
Step Four In the spring, two years after the clone was first planted, the new shoots develop a root-system and the rootstock is cut off at the original base.

Step Five Each of these new shoots (rooted cuttings) is then planted. Growers can buy these rooted shoots and bud them with selected varieties or let nurserymen do the budding and produce dwarfed, compact, "tailor-made" trees for their orchard. In the fall, the nurseryman buds in the new variety on the stock 14 in. above the ground. Next spring he cuts off the top of the clone above the bud and allows the variety to grow that summer.



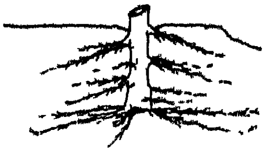
Clone – Spring, 1971.

Step One



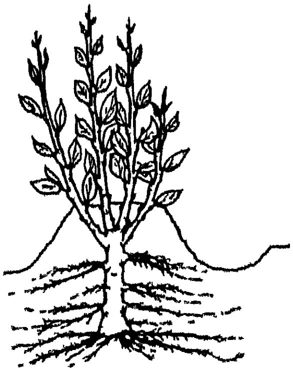
Fall, 1971.

Step One



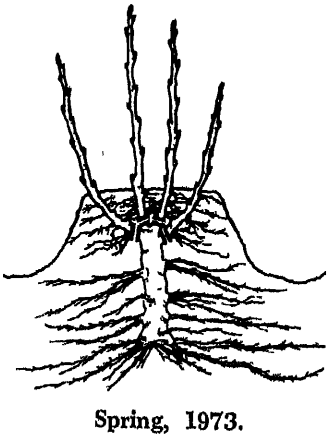
Spring, 1972.

Step Two



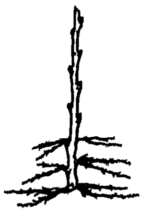
Summer, 1972.

Step Three



Spring, 1973.

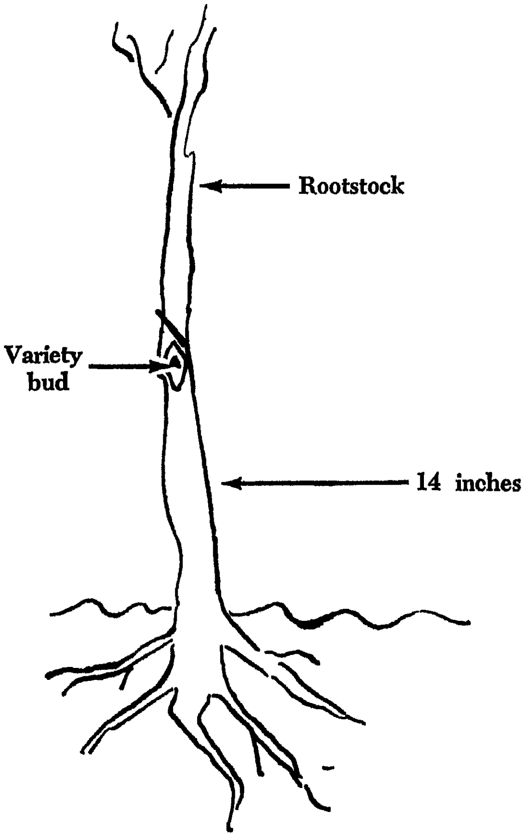
Step Four



Rooted cutting.

Step Five

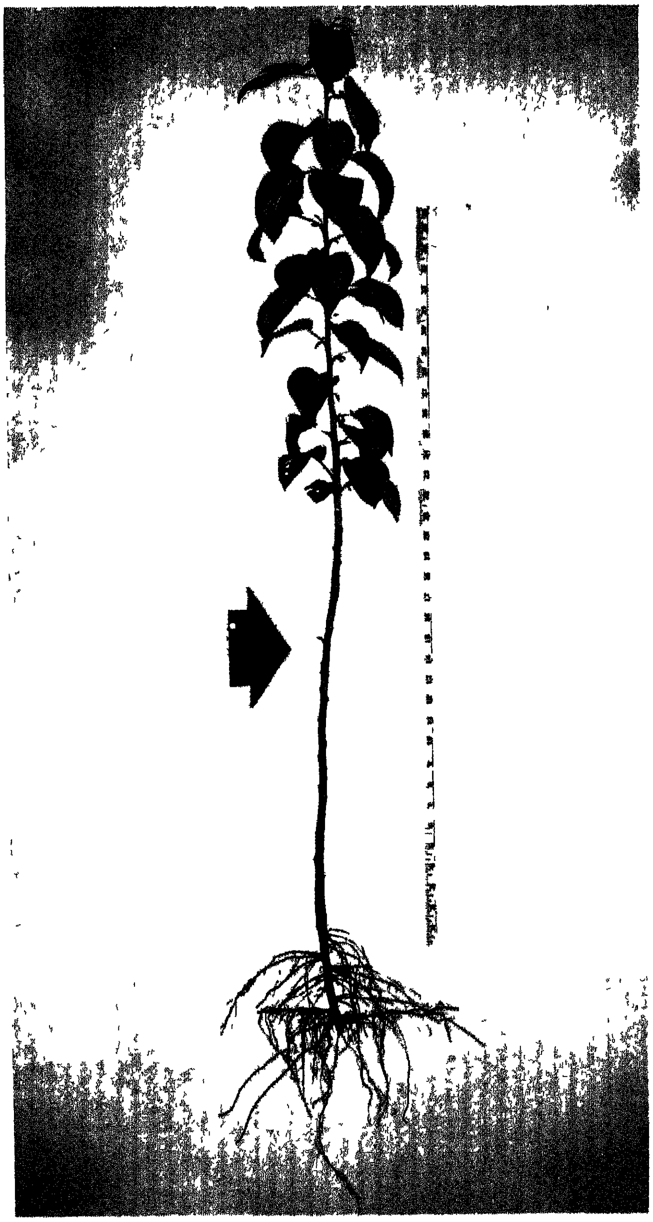
Step Six The budded tree is dug in the fall and planted in the orchard the following spring, three years after the clone was first put into the propagation bed These trees can bear fruit the first year, but usually 3 or 4 years are needed, depending on the rootstock and variety.



In the Nursery

Step Six

Trees in the nursery budded 14 in. above ground.

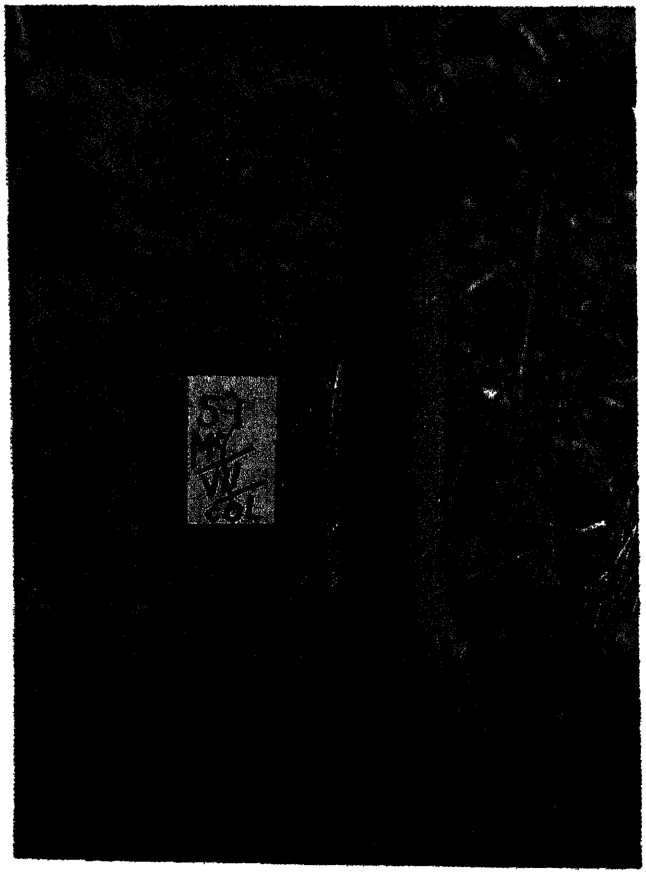


MM 106 clone rooted and budded (arrow) 14 in. high in the nursery.

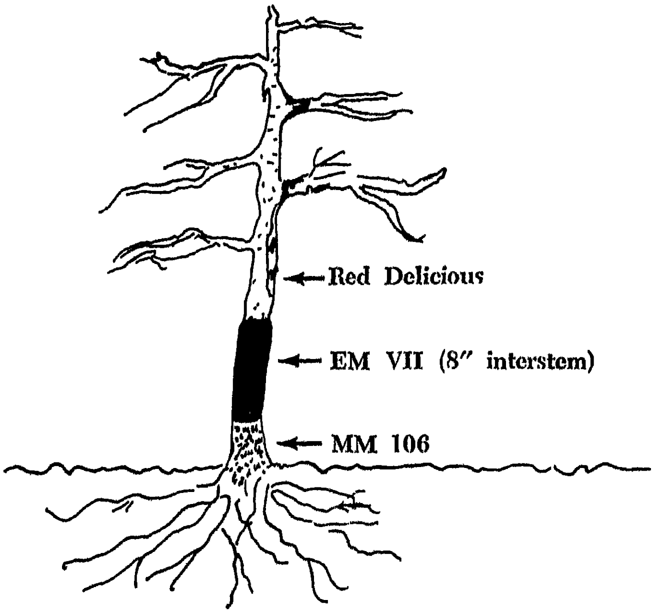
Optional Dwarfing Method

An intermediate dwarfing stem section may be placed between the seedling rootstock and the variety to produce a dwarf tree. Use an 8 in. stem section of EM IX, EM 26 or EM VII, depending on the vigor of the variety and the desired tree height.

Trees will be more uniform if MM 106 is used as the root system and the interstem and variety are grafted on top of it.



Dwarfing interstem between dwarfing rootstock and variety.



EM VII is used here at an intermediate stem section above MM 106 to dwarf Red Delicious. An interstem dwarfs the variety causing early fruiting and well anchored trees.

What Causes Dwarfing?

Mature dwarf trees stand about 6 to 10 ft. high. The complex response of a variety on a rootstock, combined in a graft union and vice versa, plus the biochemical influence of both produce this compact tree.

Good fruit production or quality cannot be obtained unless a dwarfing rootstock is budded to a scion variety. For Example, EM XVI allowed to grow naturally will become a 15 to 20 ft. tree, while EM IX grows into a small bush-like plant. When these rootstocks are budded to a variety, EM IX produces a compact 6 ft. tree and EM XVI a 12 ft. tree.

A selected variety often makes a big difference in determining the size of a dwarf tree. Some varieties are more dwarfing in themselves than others. For example, the Jonathan variety budded on EM VII yields an extremely small tree (4 to 6 ft.), while Jonathan on EM II produces a 12 ft tree with a larger bearing surface. McIntosh on the same rootstock produces a relatively larger tree.

Red Delicious (Standards)

Recommended rootstocks for low density plantings (113 trees per acre at 16x24′ spacings) are MM 106, EM II and MM 111. EM II grows into a tree that might have to be staked to keep it from leaning, especially on clay-loam soil.

For medium density plantings (201 trees at 12x18′), MM 106 is better than EM VII.

Higher density (450 trees per acre, 6x16′ spacings) requires more management. For this spacing, EM 26 is preferred to EM VII. NOTE. Some trees in high density planting may need staking or trellising.

Red Delicious on EM IX, has a tendency to get "apple measles" (a nutritional disorder) under some soil conditions. So check soil before planting this combination.

For a compact tree and low density planting, standard Red Delicious on MM 106 is ideal. Early spreading of selected scaffold branches is important for early fruiting and continued cropping. This tree is four years old.

Recommended Dwarf Rootstocks

Spur-type Red Delicious on EM VII in fourth year. This combination fits a medium density – about 350 trees per acre. Choice of the rootstock depends on soil type and orchard management.

Red Delicious (Spur-Types)

Recommended for low density planting (201 trees per acre, 12x18′ spacing) are EM II, MM106 and MM 111.

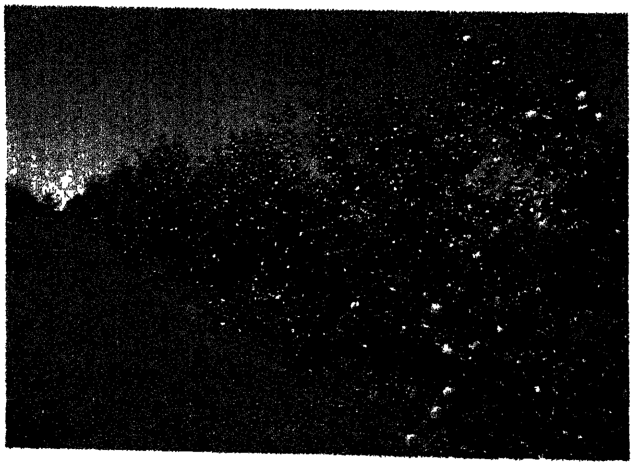
Spur-type Red Delicious trees in a medium density planting scheme should be budded on either EM VII or MM 106.

For high density (605 trees at 6x12′), EM 26 and EM VII are recommended. Some staking or trellising may be needed.

Red Delicious spur-types on EM IX make very small compact trees subject to "measles" in certain locations.

Golden Delicious on MM 106 showing fruit crop in fifth year. These trees bore good fruit the third year.

Standard Golden Delicious on EM VII planted in 1956. In the sixth year, these trees produced 1,300 bushels per acre in a medium tree density (484 trees per acre at 6x15′ spacing).



Standard Golden Delicious on EM VII in a commercial planting at 20x30′ spacing. These trees could have been planted at 8x16′.

Golden Delicious (Standard)

Golden Delicious bears early. This characteristic limits tree vigor so more vigorous rootstocks may be used. The smaller tree size permits planting more trees per acre than with Red Delicious.

MM 106 is preferred for both low density (172 trees, 14x18′ spacing) and medium (339, 8x16′). But EM II and MM 111 may be used for low density and EM 26 or EM VII for medium densities.

EM 26 is slightly better than EM IX for high density plantings (726 trees at 5x12′ spacing). Golden Delicious on EM IX are not as susceptible to apple "measles" as Red Delicious on EM IX, but this combination does not work as well in Michigan as in Oregon, Washington and the Netherlands whose soils retain moisture better. EM IX trees tend to lean and are not anchored as well as those on EM 26.

Golden Delicious (Spur Types)

On low density (218 trees, 10x20′ spacing) use either MM 111 or EM II, but MM 111 produces a tree with better anchorage, resistance to woolly aphids and early fruiting.

On medium density (453 trees, 8x12′), MM 106 is preferred to EM VII, but either can be used. MM 106 trees have more bearing surface, better anchorage and earlier fruit.

For high density (1089 trees at 4x10′), EM 26 is suggested more than EM IX because the trees are more vigorous, better anchored and have more bearing surface. Some staking or trellising is needed with trees on either rootstock.

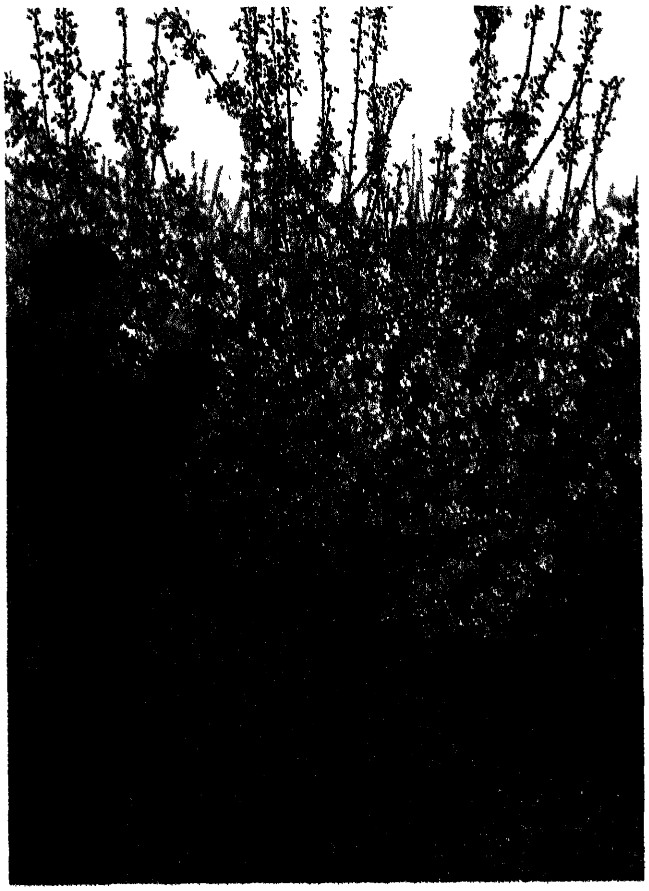
McIntosh

For low density plantings (113 trees, 16x24′) MM 106, EM II, and MM 111 are good.

For medium plantings (312 trees, 10x14′) EM VII has a slight edge over EM 26 because it dwarfs the variety, producing very fruitful trees that stand up well.

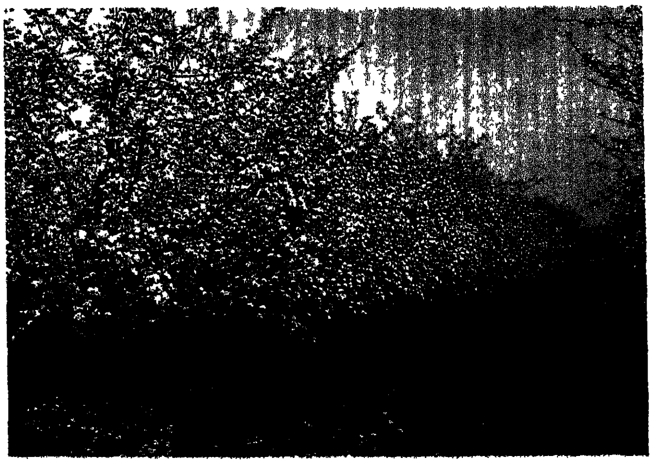
For high density (605 trees at 6x12′), both EM IX and EM 26 are suggested. But again EM 26 is preferred. Trees on either rootstock require some staking or trellising.

Four-year-old spur Golden Delicious on rootstock EM 26 shows good fruiting and tree form. Intensive tree training management is needed with most varieties on this rootstock and with high density plantings.



McIntosh on EM VII five years old. The trees are well anchored, productive and produce good fruit quality at medium density plantings of about 300 trees per acre.

McIntosh on EM VII rootstock with 72 trees per acre and yielding 1,600 bushels per acre in its 10th year.



McIntosh on MM 106 (left) and on MM 111. Both combinations are excellent on sandy loam soils and in low density plantings of about 100 trees per acre.

Jonathan

MM 106 and EM II are generally preferred for low density planting (201 trees at 12x18′ spacing). But MM 111 is best for orchards on a droughty site.

For medium density planting (453 trees at 6x16′), MM 106 gives a very productive tree with good bearing surface EM 26 is acceptable, but produces a smaller and weaker tree.

For high density planting (605 trees at 6x12′) use either EM 26 or EM VII. Some staking or trellising will be needed.

Northern Spy

On low density plantings (113 trees at 16x24′), MM 106 and EM II are recommended. But MM 106 is preferred because its trees are better anchored and bear earlier

For medium density planting (201 trees at 12x18′), either EM VII or MM 106 are satisfactory, but EM VII tends to "sucker" (produce shoots below ground). When used with Northern Spy, it produces trees that tend to lean.

For high density plantings (518 at 6x14′) consider either EM IX or EM 26. Research shows EM IX will produce a smaller tree, but information is limited on the compatibility of EM 26. Staking may be needed on medium and high density plantings.

Rome Beauty

Three rootstocks are recommended for low density planting (201 trees at 12x18′ spacing), MM 106, EM II and MM 111. MM 106 or MM 111 are suggested because they give good size control.

In medium planting (453 trees at 6x16′) either EM VII or MM 106 are acceptable, but MM 106 produces a larger tree.

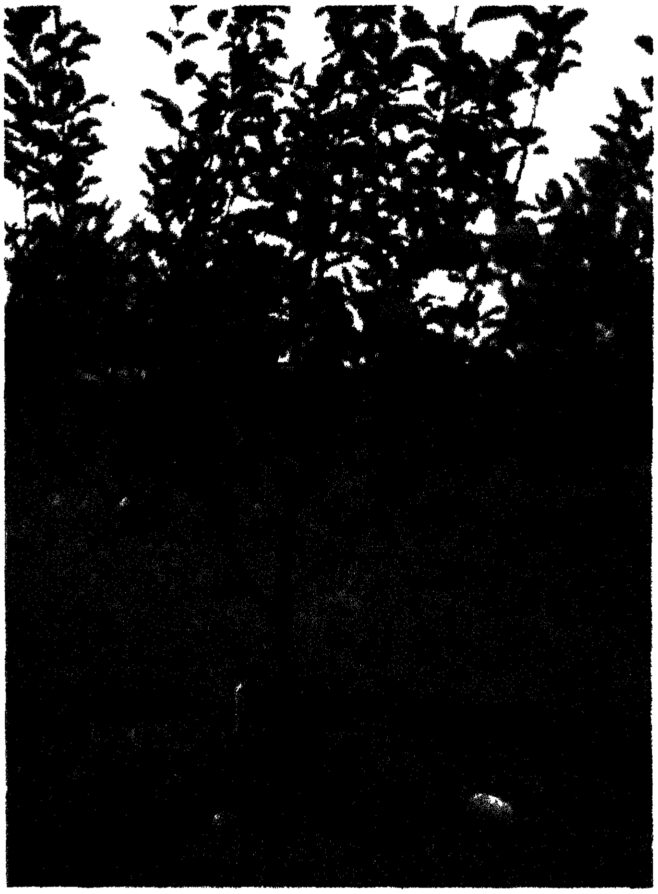
For high density (605 trees at 6x12′) EM 26 is preferred to EM IX. EM 26 produces a tree with better anchorage and a slightly larger bearing surface.

Trees in medium and high spacing need some staking or trellising.

Jonathan on EM II fruiting in the fourth year. Fits well into low density orchard with 200 trees per acre.

Top fruit quality and color — products of Jonathan on a recommended dwarf rootstock.

Nine-year-old Northern Spy on MM 106 showing early tree spreading and fruiting.



Three-year-old Northern Spy on EM IX. This combination fruits early and, with proper management, can be handled in medium or high density plantings up to 500 trees per acre.

Management-Plus Factor

Warning: Dwarf trees do not guarantee fruit growing success. Good management is needed, especially in high density plantings.

Using recommended rootstocks will control tree size, but compact trees must be pruned and headed back annually to control vigorous growth. Certain branches should be bent or braced outward to keep young trees (especially Red Delicious) open, so more bearing surface is exposed to sunlight. Every effort should be made to keep trees bearing each year This keeps the trees small. A controlled nutritional program is also essential.

Finally, score the trunks of vigorous varieties to obtain large yields every year. Cut through the bark around the trunk below the lowest branch 14 days after the tree reaches full bloom. Scoring trees of vigorous varieties helps the tree adjust its carbohydrate-nitrogen balance, enabling existing flowers to set fruit and initiate more flowers for the next year. This technique encourages fruiting every year. Scoring is recommended for Red Delicious, Winesap and Northern Spy.

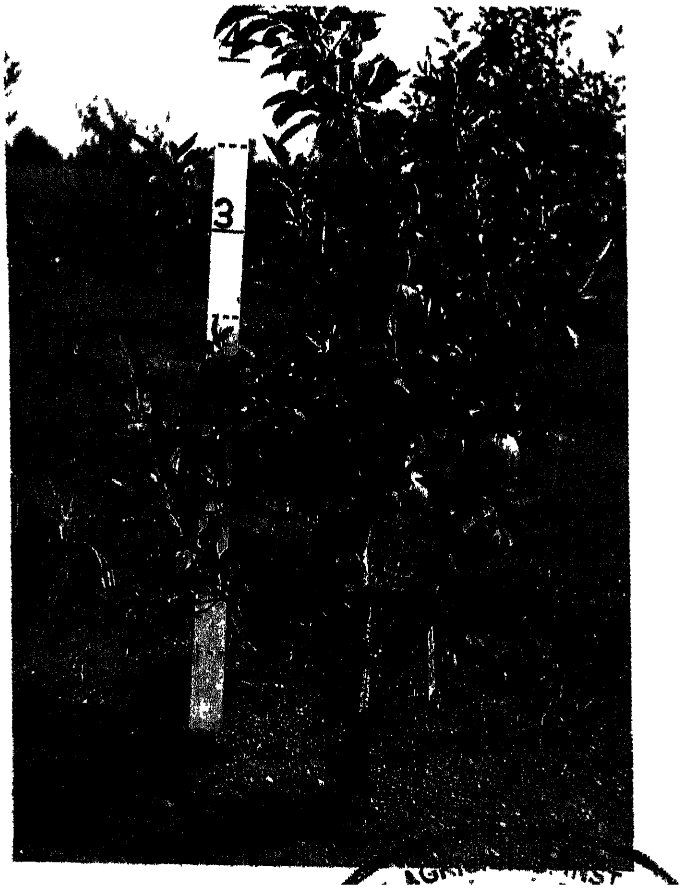
The Future

Shorter, bush-like trees in high density plantings are likely to produce more fruit per acre in the future. By 1980, many growers will be planting trees at 4x8′ spacing – about 1,300 trees per acre. This will be a dramatic change from the 30x40′ spacings – about 35 trees per acre – that were common 20 years ago

By 1980, many orchards will yield 2,500 to 3,000 bushels per acre – 5 to 7 times what they get now from standard and dwarf trees.

The fruit will have better brighter color, good taste, more uniformity and be better suited to mechanical harvesting. MSU horticulturists and engineers work together to develop these dwarf "giants" of the future, so harvesting machines will be ready when the trees are.

Michigan State University researchers are working to develop better rootstocks and the best possible rootstock-variety combinations for apple, pear, peach, plum, cherry and apricot trees. In the future, growers will use real dwarfs – very compact, highly productive and early bearing. One of these, EM 27, should be available by 1975. Hopefully, it will be compatible with most commercial apple varieties and produce bush-like trees that can be planted in excess of 1,000 per acre.



TOWARD THE FUTURE – Trees like this could be planted and managed in a 4x8′ spacing (1,361 trees per acre). This is a spur type Red Delicious on EM 26, and would yield about 400 to 500 bushels per acre in its 3rd and 4th years. These trees will be sturdy and able to carry up two bushels per tree when they are 6 to 8 ft. high and 2 ft. wide. At this rate, they could produce about 2,700 bushels per acre.

Other MSU publications on Horticulture and related fields.

Research Reports

RR-23	Packing Industry, Fresh Apple
RR-62	Use of Fumigants and Clear Plastic Mulch on Muskmelons
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RR-69	Preharvest Spray Cooling for Tart Cherries
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Extension Publications

F-122	Pruning Young Fruit Trees
F-205	Grader's Manual (Tomatoes)
F-281	Pruning Deciduous Shrubs and Woody Vines
E-469	Black Knot of Plum and Cherry
E-486	Micronutrients for Fruit and Vegetable Crops
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FROM THE MICHIGAN STATE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION, EAST LANSING
APRIL 1971

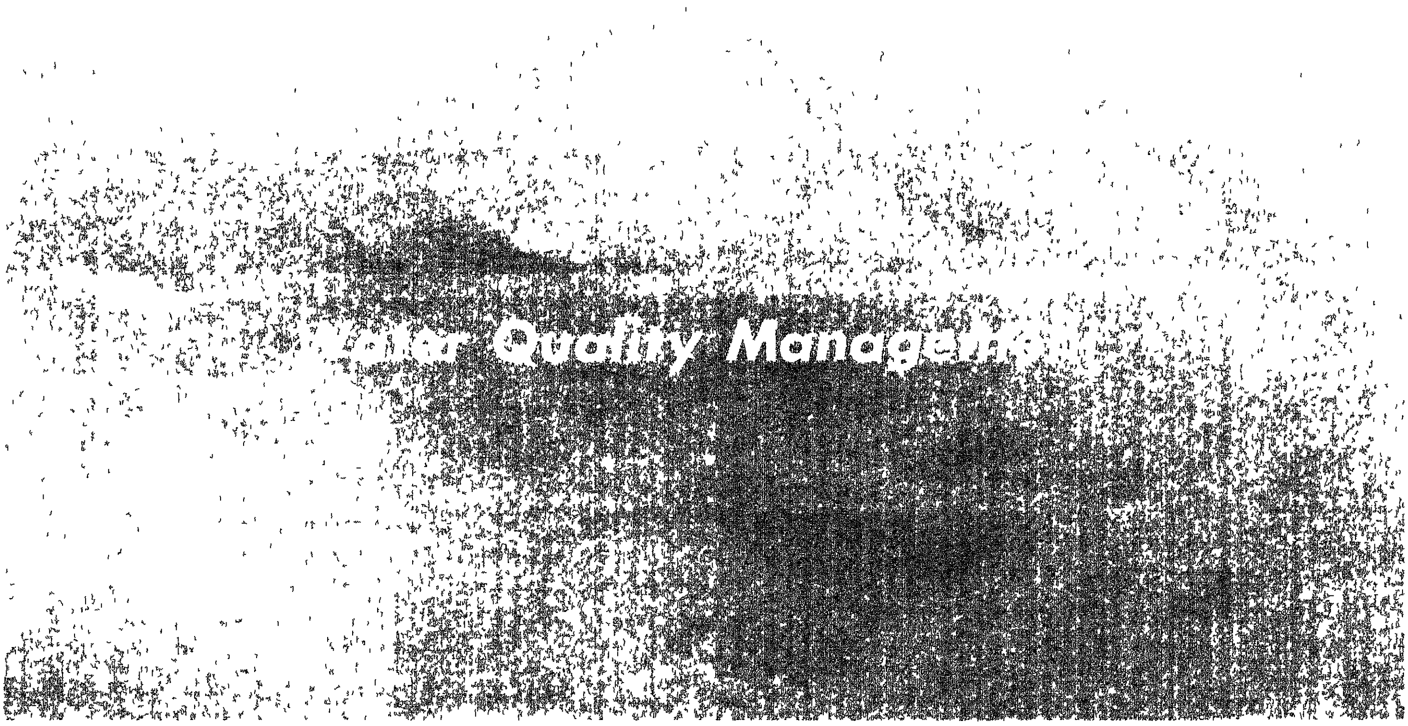
18 Focus on Water Quality Management

Until recently, man's interference with the environment around him has been fairly localized. But with rapid increases in population, technological advances, energy requirements and the standard of living, environmental degradation has begun to assume global significance.

Management of the world's resources and the environment in general has reached a critical point. There are few precedents from the past to suggest how man can intelligently achieve the quality and quantity of resources required now and for the future.

This publication reviews some of the programs undertaken by scientists and other research personnel of Michigan State University who wish to help communities, organizations and individuals to understand and control environmental problems related to water use.

Cover: Presque Isle Falls, Gogebic County
(Courtesy of Michigan Tourist Council)



The cities of Michigan and the entire nation are faced with serious threats of pollution requiring action based on imaginative research.

In an attempt to cope with water use problems in our modern society, Michigan State University has devised a new concept of water quality management.

This project, proposed by MSU's Water Research Institute, is designed to test and demonstrate methods of treating and reusing water in a way that will protect the quality of the environment.

Three Objectives

The program has three primary objectives: research, providing regional service and information, and teaching.

Specialized water quality management training will be provided to persons seeking careers in professional practice, teaching, research, or community service. The program will provide information to the community and its leaders regarding water quality and environmental conditions.

Non-credit programs in a continuing education series will be developed to serve a broad audience with interest in water quality management. The program will also support seminars and conferences to give information on water resources to scientists, engineers, administrators and other interested groups.

Field Laboratory

The MSU management plan calls for developing a Water Research Field Laboratory on campus. This would include a series of shallow reservoirs, a central lab building, wooded acres, open field plots and several lesser facilities.

The development is intended to be a permanent unit illustrating how to use the earth's natural resources fully and still prevent destruction of the natural environment.

Domestic waste water treated at the city of East Lansing's Wastewater Treatment Plant will be piped to the MSU project site, where it will be impounded in a series of small lakes.

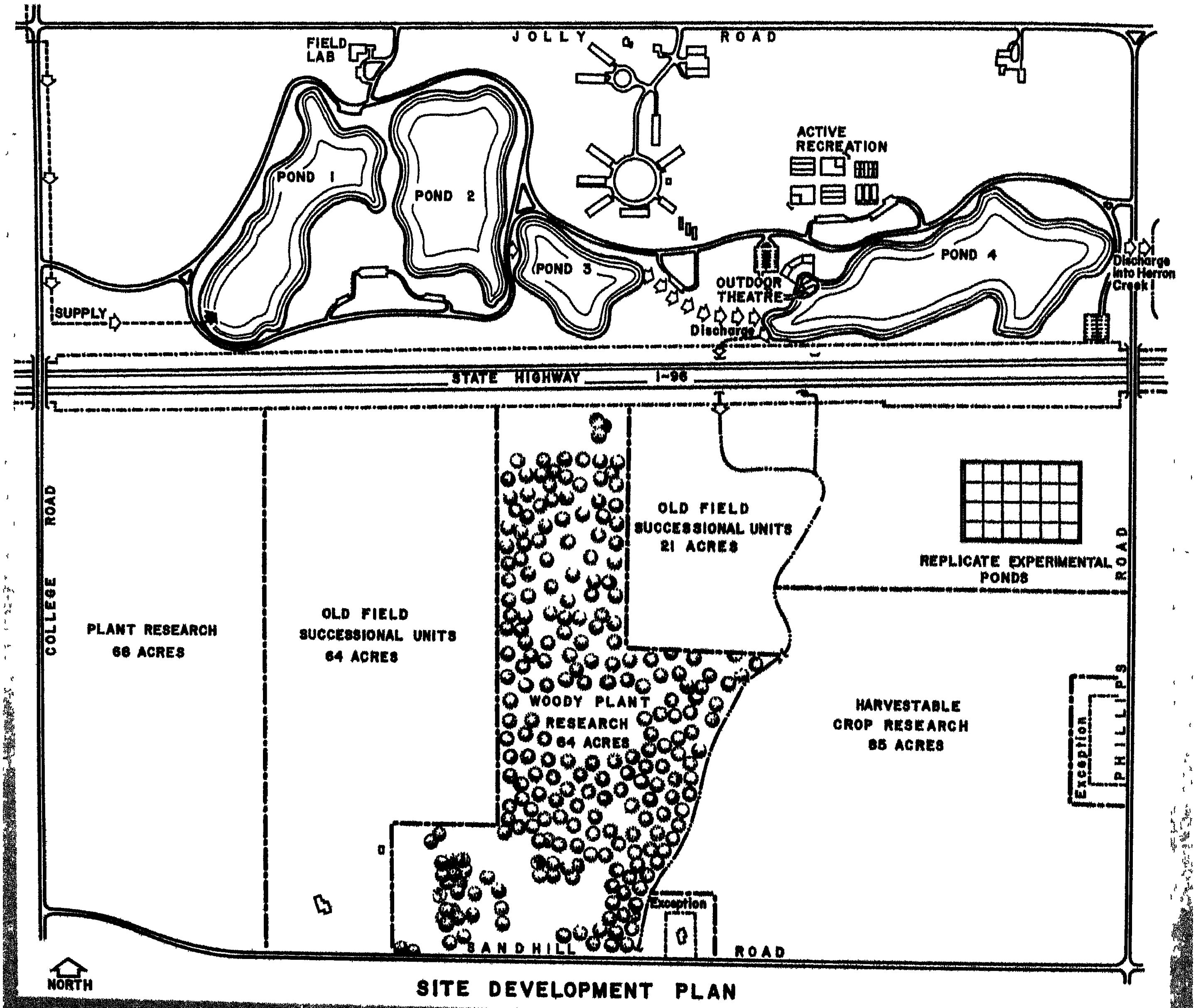


Fig. 1. Proposed Water Research Field Laboratory intended to be a permanent unit illustrating how to use natural resources wisely.

The biological activity of plants and animals in this aquatic system will reduce nutrient levels in the water and improve the quality of the water as it moves through the series of lakes. Additional nutrient removal will be accomplished by various terrestrial plant communities, including farm crops treated by irrigation.

Extensive investigation and manipulation will be necessary to maintain a balance between nutrient input and the rate of uptake for phosphorus and nitrogen. A comprehensive withdrawal system will transport water of selected nutrient levels from the reservoirs to the surface application sites. There it will be distributed on experimental irrigation plots of cultivated crops, forage crops and woodlots to determine the value of this procedure on the uptake of nutrients and the value of the nutrients in crop production.

Discharge from the terminal lake will be released under controlled conditions to natural water courses leading to the Red Cedar River.

Teaching and research activities will cover a variety of investigations, incuding extensive aquatic plant cropping to stimulate nutrient uptake. Tests will also be made to determine whether animals that graze on these plants show increased rates of production.

Plans for a community park and recreational benefits centered around the lake system will also be included in the program.

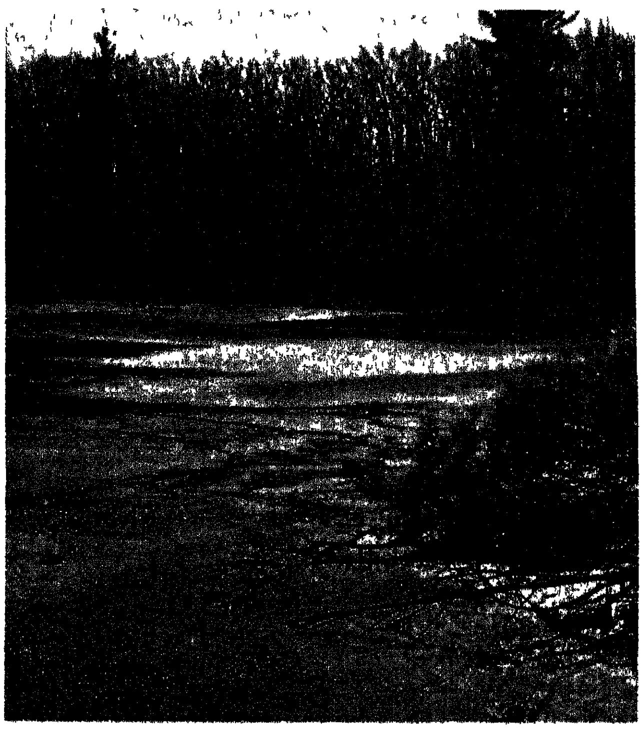


Fig. 2. Aquatic weeds often cause problems in waters which formerly had been used for recreation.

Aquatic Weed Control

During the next 30 years, the demand for water recreation areas is expected to triple. Uses of quality water for other purposes will also increase sharply, while the supply of adequate ponds, lakes and streams desirable for recreation will decrease.

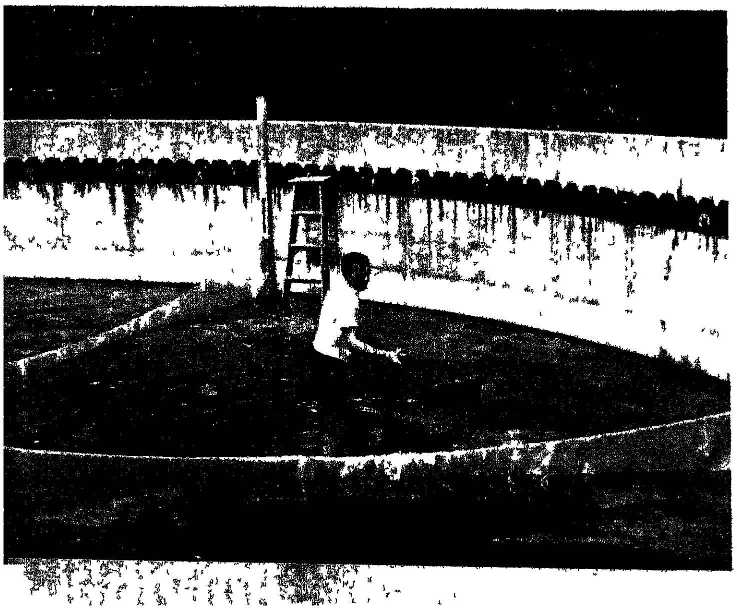
Many streams and lakes, including Lake Erie, have already lost much or all of their recreational value. This water degradation is caused primarily by massive pollution. Changes in water quality have been rapid and dramatic, often resulting in protest by local residents.

Lakes, streams and ponds may be ruined for scenic and recreational use by very small additions of nitrogen, phosphorus, or treated sewage. All of these stimulate the growth of nuisance plants.

Aquatic plants by themselves may or may not be harmful. They are important sources of food and shelter for waterfowl and other wildlife in marshes and ponds. However, aquatic weeds can cause problems in waters used for recreation.

Fig. 3. Filamentous algae masses are comprised of tiny threadlike parts which, in an underwater environment, are barely visible to the naked eye.

Fig. 4. Dr. Vernie Knudson collects aquatic weed samples from testing tanks on the MSU campus.



Cause Problems

Nuisance plants range from filamentous algae, whose individual "threads" are almost too small to be seen, to large cattails. These weeds make water look unsightly, discourage water sports, make motorboating and rowing difficult, entangle fishing lines, and allow small fish to escape from larger predator fish, causing a decrease in the number of large gamefish available for sportsmen.

In addition, decaying plants use up oxygen, causing fish deaths.

Nuisance plants emit odors and tastes to the water, promote mosquito growth and swimmer's itch, clog pumps, pipes and streams, and fill up the edges of a pond or lake until it becomes continuously smaller and shallower.

The trouble nuisance plants cause is usually in direct proportion to their size and numbers. Studies at MSU have shown seven tons of plants present in a single acre of water. Duckweed alone can form a blanket comprising three tons of weeds per acre.

Control Methods

Some physical methods for aquatic weed control include dredging, cutting, mechanical removal, clearing out trash, and preventing sediment from reaching the lake, pond, or stream.

Black plastic laid on a lake bottom and covered with sand can prevent growth of large rooted aquatic weeds and provide an attractive recreation beach. Cutting by hand or machinery may control unwanted vegetation on a temporary basis. Silt traps, sodded waterways and narrow shelves or ledges can prevent sediment from entering and filling ponds.

Fertilization

Fertilization of ponds is sometimes recommended for aquatic weed control, but in Michigan results are erratic and may be detrimental. The fertilizer can promote heavy growth of filamentous algae which interferes with fishing and may cause an oxygen deficiency when the algae decays.

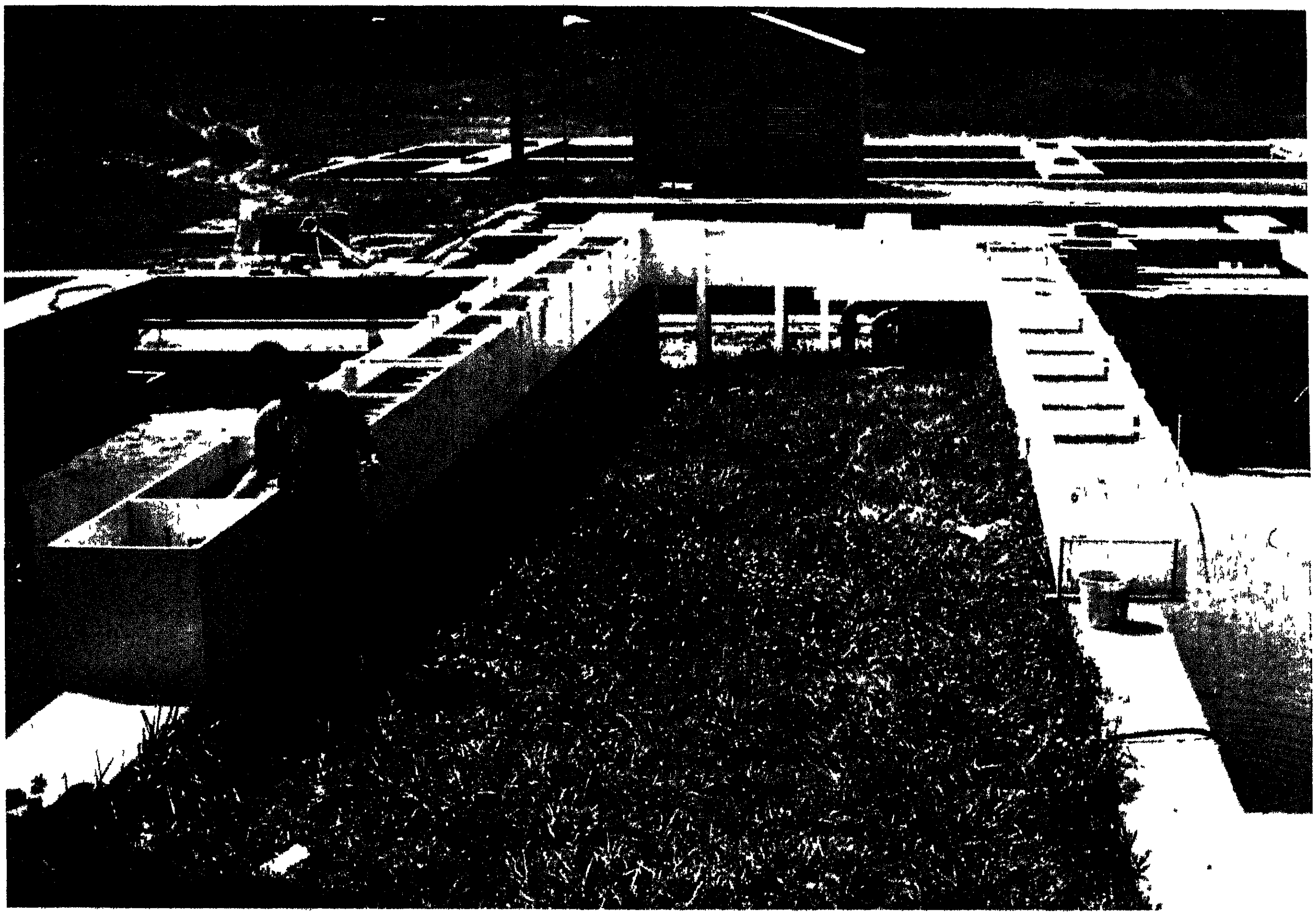


Fig. 5. Several types of aquatic weeds are grown for research purposes at Michigan State University's River Laboratory.

Using Herbicides

MSU researchers have found the use of herbicides is the quickest and easiest method of controlling aquatic weeds. Effective control depends upon the selection of the best herbicide for a given situation; a chemical which is appropriate in one case may not be suitable in another.

Identification of the nuisance plants is necessary before treatment since no herbicide can control all plants. Experiments on aquatic weeds at MSU have demonstrated vast differences in the speed and effectiveness of each herbicide.

Certain extreme conditions, such as turbidity, low temperature and hardness of water can prohibit the use of some herbicides.

MSU scientists advise treatment should always proceed with caution. Rates of application should not be increased to get faster control since higher dosage rates could kill fish or fish-food organisms. Research at East Lansing shows certain herbicides are lethal to fish-food organisms at concentrations considered safe for fish.

Permit Required

A permit is required for using the herbicides sodium arsenite, copper sulfate or dicocoamine salt of endothal in public waters or in water which overflows or seeps into the natural watershed. Permission to use these chemicals must be obtained from the District Fish Biologist, Michigan Department of Natural Resources.

An Alternative

MSU is exploring the possible use of fish which might act as biological controls as an alternative to chemical control. Tilapia melanogaster, an African fish which eats submerged aquatic weeds, could help keep lakes and ponds free of excess nuisance weeds. This fish can live and reproduce in Michigan during the summer, but is probably too sensitive to cold temperatures to survive the northern winters.

Pesticide Pollution

One of the water quality problems facing Michigan is pesticide pollution.

Scientists in MSU's Department of Fisheries and Wildlife are making intensive studies of the effects of pesticides on fish. One of the most important programs involves the Great Lakes exotic new sportfish, the coho salmon.

Preliminary investigations began in 1967 to identify and quantify pesticide residues in coho eggs taken from Lake Michigan salmon and to determine the effect of the chemicals on hatching fry (newly born salmon).

High Pesticide Level

MSU researchers found DDT concentrations in Lake Michigan coho salmon eggs were three to five times higher than in those from Lake Superior and nearly 60 times greater than in Oregon salmon eggs.

Dramatic losses of important fishery resources have been attributed to pesticides, and yet the biological significance of pesticide residues for human consumption is poorly understood. The potential effect of "persistent" pesticides on the reproduction of various fish species is of immediate concern.

Fig. 6. Michigan State University research team nets salmon from one of northern Michigan's spawning streams. Preliminary studies were started in 1967 to identify and quantify pesticide residues in coho eggs taken from Lake Michigan salmon.

Mortality Syndrome

In the MSU laboratories, a mortality syndrome, characterized by an abrupt appearance of disoriented movements and convulsions during the last stage of yolk sac absorption, was observed in all groups of fry hatched from Lake Michigan salmon eggs. This was not observed in fry from Lake Superior and Oregon salmon.

High pesticide residues in the eggs of Lake Michigan salmon were generally associated with high mortalities among the fry.

Much higher concentrations of DDT were found in affected fry than in non-affected fry from the same female.

DDT concentrations in the last fractions of yolk present in the gut when mortality syndrome symptoms first appeared were 6 to 12 times higher than in the body tissues of the tested salmon fry. The absorption of DDT from the gut into the circulatory system was suggested as the cause of the young fry mortality.

Fig. 7. Dr. Howard Johnson (r) examines salmon while student in background records pertinent data.

Widespread Contamination

Lake Michigan, whose drainage basin is nearly 45,000 square miles, is subject to continuous contamination by pesticides from large areas of intensive agriculture and from densely populated urban centers.

After a three-year monitoring study of Great Lakes fish, DDT was found in all species, but concentrations in Lake Michigan fish were two to four times higher than in fish from other lakes.

In addition to the salmon program, studies are being made of the accumulation, excretion and storage of pesticides in warm-water fish, and researchers are trying to find a possible antidote for the chemicals.

Study Movement

Finally, scientists are studying the movement of pesticides in the aquatic food chain to find out how long pesticides remain in the water, when and where they accumulate in fish and other organisms, and if they break down into non-toxic chemicals.

MSU researchers use the most sophisticated equipment and methods available in their attempt to help Michigan better manage the state's greatest natural resource — its water.

Nutrients, Rough Fish, and Bass

Since concern for environmental quality is paramount among scientists and laymen alike, much attention is focused on the various effects of nutrients on water and aquatic life.

Excessive nutrients are added to waterways through domestic sewage and cropland drainage. These nutrients (nitrate and phosphate) stimulate plant growth. The combined photosynthesis and respiration activity of the plants causes a daily fluctuation in the amount of dissolved oxygen present in the water. Further reduction of oxygen content results from bacterial action occurring when the aquatic plants die and decompose during autumn and winter.

Experiments have shown reduced oxygen levels, even if they occur for only part of the day, will reduce the growth rate of several species of game fish. Extremely low oxygen levels may be lethal to game fish, which generally have higher oxygen requirements than rough fish.

Game Fish vs. Rough Fish

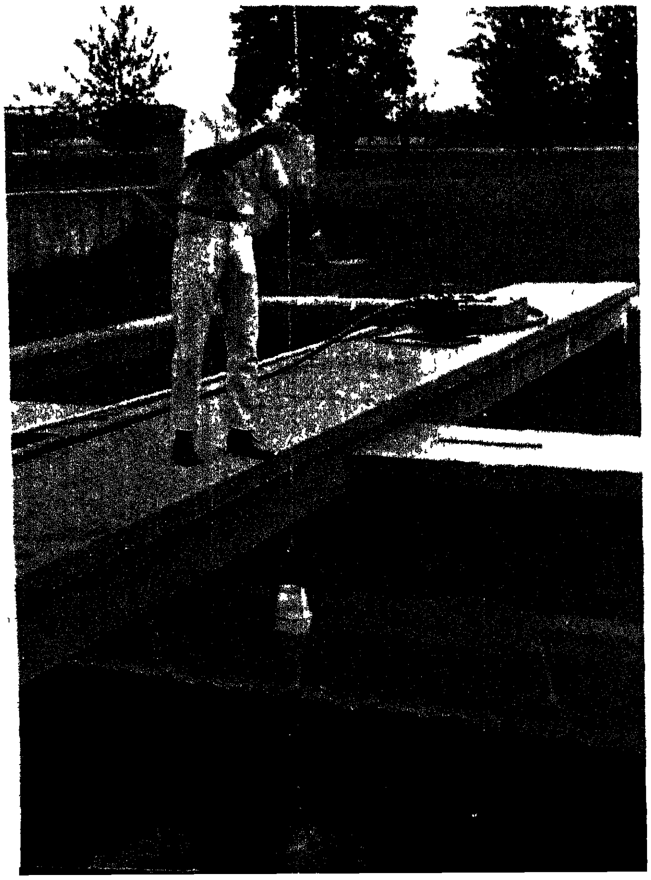
MSU researchers are involved in an experiment to determine whether excess nutrients affect species composition of fish populations and whether competition exists between game fish and rough fish. The fish used in the study are smallmouth bass (a game fish) and carp (a rough fish).

Twelve concrete ponds have been stocked with fish at natural densities. One-third of the ponds contain bass only, one-third carp only, and the remainder a mixture of both.

Half of the ponds (two of each type) are fertilized weekly to produce the high nutrient levels found in moderately polluted waters. Biweekly samples are taken to determine the actual levels of nutrients in the water and the amount of food organisms present in the various ponds.

After a specified time lapse, the ponds will be drained and the growth and survival rates of each fish species will be determined for each population type and fertility level. It may then be possible to determine whether a decrease in a fish population was due to lack of food, competition from another species, or water conditions resulting from high nutrient levels.

Fig. 8. The plankton sampler here is used to obtain small food organisms from this pond.



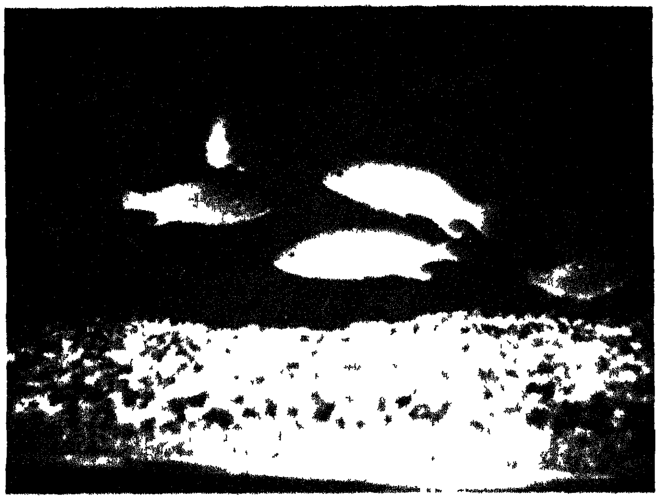
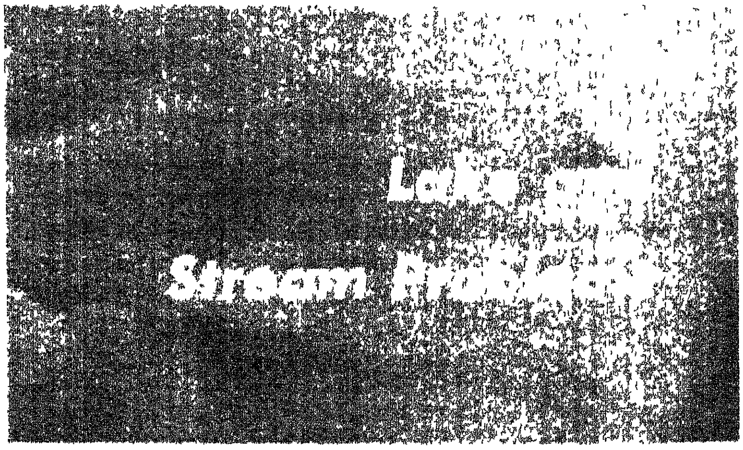


Fig. 9. Carp and bass are studied for growth and survival rates.



Historically, water quality standards have evolved slowly. Early efforts were geared toward protecting public health rather than the needs of recreation, agriculture and industry.

Michigan now has a set of water quality standards whose formulation was assisted by several staff members of Michigan State University. As a result, each lake and stream in the state has been classified according to its most important use.

Lakes Classified

Many lakes have been classified as "total body contact" lakes. Water in these lakes is pure enough to permit total body contact sports such as swimming, water-skiing and skin-diving. Michigan's new water quality standards will protect these waters from unwise development or actions which could degrade their quality.

Streams must also be classified as to use since they are frequently exploited for different purposes For instance, the extreme upper tributaries may be classified for cold-water fish such as trout, the middle portion for warm-water fish, and the downstream section near the mouth for industrial use.

Research programs are underway at MSU to determine the impact of the new standards on certain major water user groups.

Rural Program

Michigan State's Cooperative Extension Service program in rural areas is promoting interest in water quality management. Several lake and stream associations have been encouraged to establish local water quality monitoring programs to "watch dog" their water resources and determine if changes result from new uses or development.

Continued protection of water quality is necessary because it affects current and future use. Already many lakes in southern Michigan suffer acutely from overdevelopment and overuse MSU surveys found overdevelopment in this section of the state consists of: narrow lots· aound the entire shoreline, multi-tier subdivisions, canal development, trailer parks, filling and dredging, and unlimited access through rental units, marinas, parks, and fishing sites.

Fig. 10. Water in this lake is still pure enough to permit "total body contact" sports.

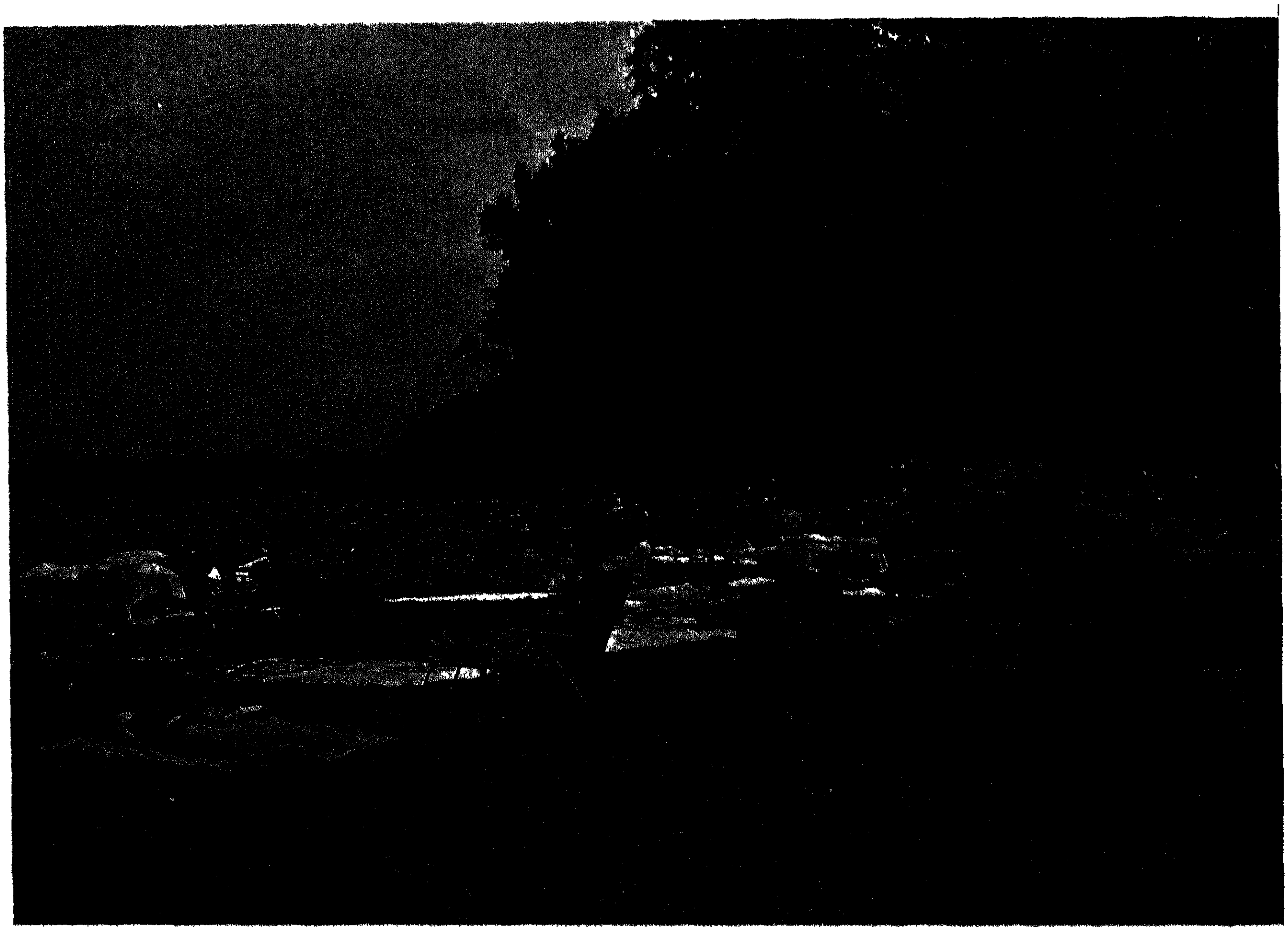


Fig. 11. In southern Michigan, lakes often receive extensive recreation-use, as evidenced in this scene. (Mich. Dept. of Natural Resources Photo)

Dying Lakes

The results of overdevelopment are becoming more obvious by frequent stories of dying lakes. The major ills of an overdeveloped lake include: a boating conflict between skiers and fishermen, intense algae and aquatic plant growth, basin filling by organic plant residue, and a decrease in fishing quality. Overdevelopment also results in water quality of questionable purity for swimming.

The advanced ills of southern Michigan lakes may be extremely difficult or impossible to cure, but there is still hope for northern Michigan waters. Prevention is more logical and successful than costly cleanup or restoration programs.

Shoreland Zoning

Water specialists from MSU have been advocating a system of "shoreland" and "greenbelt" zoning for northern lakes and streams.

These ordinances can prevent overdevelopment and overuse by requiring minimum lot size, a setback requirement for cottages, limitation of multi-tier development, rigid septic tank-tile field specifications, and protection of shoreland vegetation.

Some townships in northern Michigan have adopted such ordinances and others are investigating their feasibility.

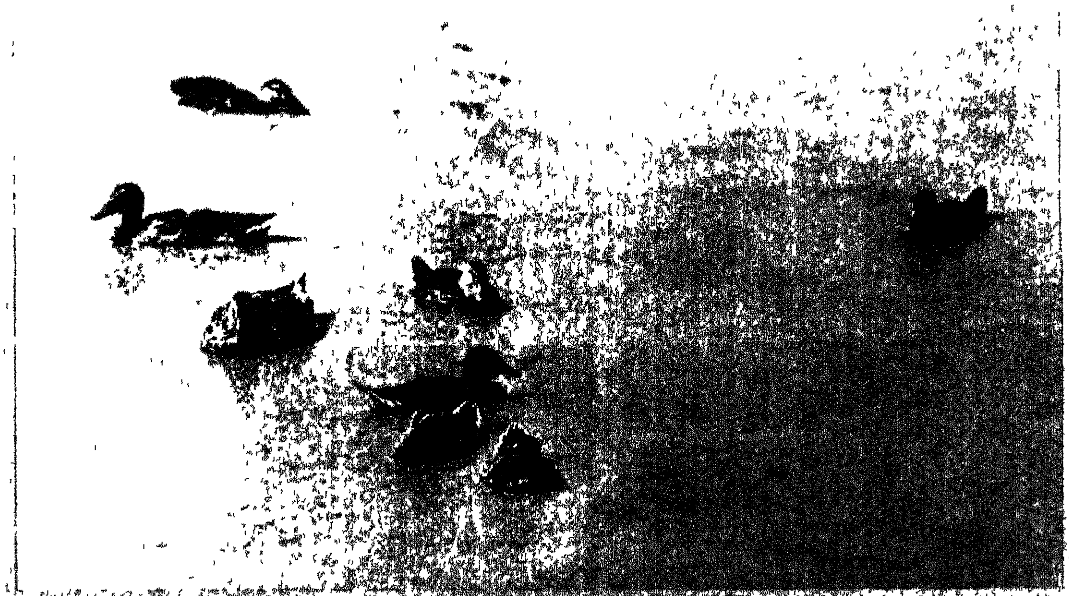


Fig. 12. Ducks swim in a virtual "sea" of tiny green algae on a southern Michigan pond.

Fig. 13. Greenbelt zoning can protect quality trout streams such as this wild stretch along the Upper Peninsula's Slate River. (Mich. Dept. of Natural Resources Photo)

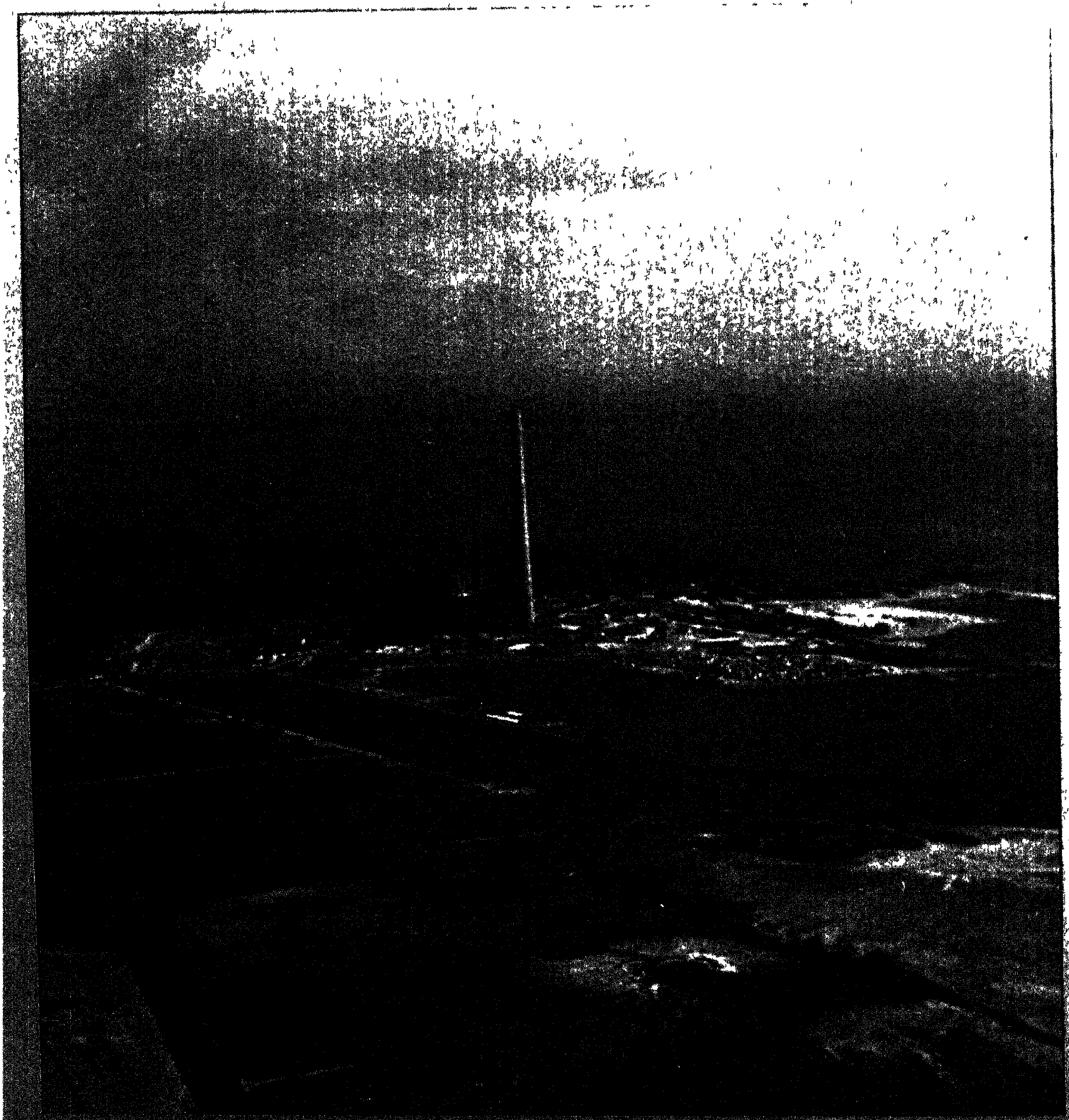


Fig. 14. This plant, under construction on the shores of Lake Erie, will become the largest electric power producing plant in the world. MSU will conduct a four-year survey here to determine the effect of water warmed in the generating process, and then discharged back into the lake.

Heat Pollution

Much public concern has been generated recently by thermal or heat pollution. This type of pollution occurs when water, heated by industrial processes or power generating plants, is dumped into the stream or lake from which it was taken without being cooled.

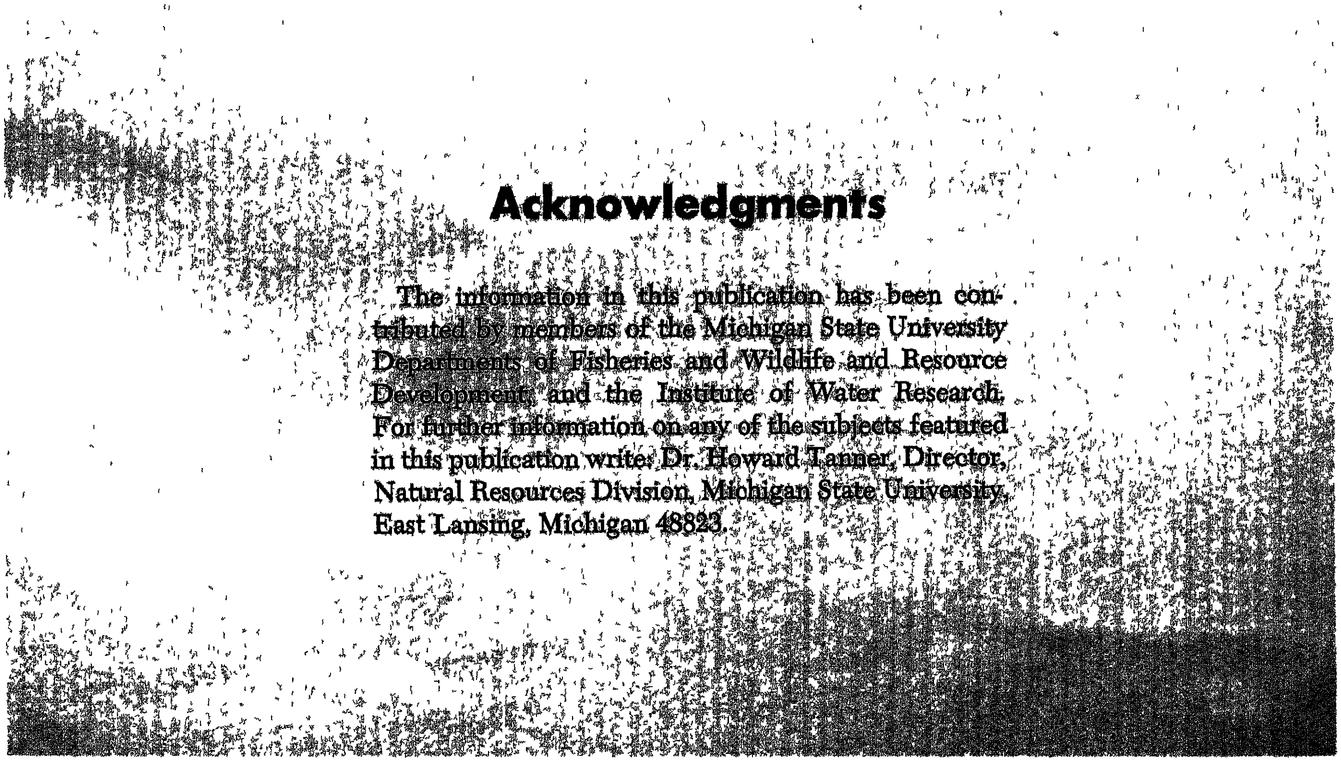
The Institute of Water Research at MSU has contracted with the Detroit Edison Company to evaluate the effects of heated effluent from a large steam generating plant under construction on the shores of Lake Erie.

Water for use in the plant will be taken from Lake Erie near the mouth of the Raisen River, warmed in the generating process, then discharged back into the lake. The MSU survey will run four years, evaluating the extent and degree of warming in lake waters and its effect on lake ecology.

Before and After

Present conditions in the lake were determined before the plan began operating in late 1970. Scientists will continue to define any ecological changes. Information will be gathered on fish populations, smaller animals which fish feed on, water chemistry and algae, the ultimate source of food for all animals.

Research will concentrate on the effects of heated water on the abundance, production, and species composition of plant and animal life, and the fate of important nutrients that play a major role in the growth and survival of these organisms.



Acknowledgments

The information in this publication has been contributed by members of the Michigan State University Departments of Fisheries and Wildlife and Resource Development and the Institute of Water Research. For further information on any of the subjects featured in this publication write: Dr. Howard Tanner, Director, Natural Resources Division, Michigan State University, East Lansing, Michigan 48823.

Section 37.20, P. L. & R.

AGRICULTURAL EXPERIMENT STATION
MICHIGAN STATE UNIVERSITY
EAST LANSING, MICHIGAN
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FIRST CLASS

This is the Eighteenth in a series of "Michigan Science in Action" publications aimed at relating the research developments in specific areas within Michigan State University's Agricultural Experiment Station.

Others in this series may be received by writing to the MSU Bulletin Office, P.O. Box 231, East Lansing, Michigan 48823.

2 — Sod and Turf — Michigan's $350 Million Carpet
4 — Focus on the Family
5 — Reshaping the Soil
6 — Focus on Beef Cattle
7 — Bedding Plants: Michigan's Blooming Industry
8 — Scientific Achievements: 1888-1969
9 — Focus on Dairy Nutrition
10 — The Bountiful Business of Bees
11 — Focus on Forestry
12 — "Tailor-Made" Vegetables
13 — Focus on Cattle Infertility
14 — Concentrate on Consumers — Mastering the Markets Serving Us
15 — Biological Control Story
16 — Focus on Michigan's Bean Industry
17 — Developing Dwarf Apple Trees

michigan SCIENCE IN ACTION

FROM THE MICHIGAN STATE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION, EAST LANSING
JULY 1972

This is the 19th in a series of "Science in Action" publications aimed at reporting research developments in specific areas.

Flower Power refers to the size and scope of the Michigan flower industry and its related research.

Scientists and specialists in Michigan State University's Agricultural Experiment Station and Cooperative Extension Service work to efficiently produce and maintain better flowers and to pass on these techniques to growers, wholesalers, retailers and consumers. This interdisciplinary effort involves several flower associations, growers and MSU departments. However, in this report, we've concentrated on the work of four men:

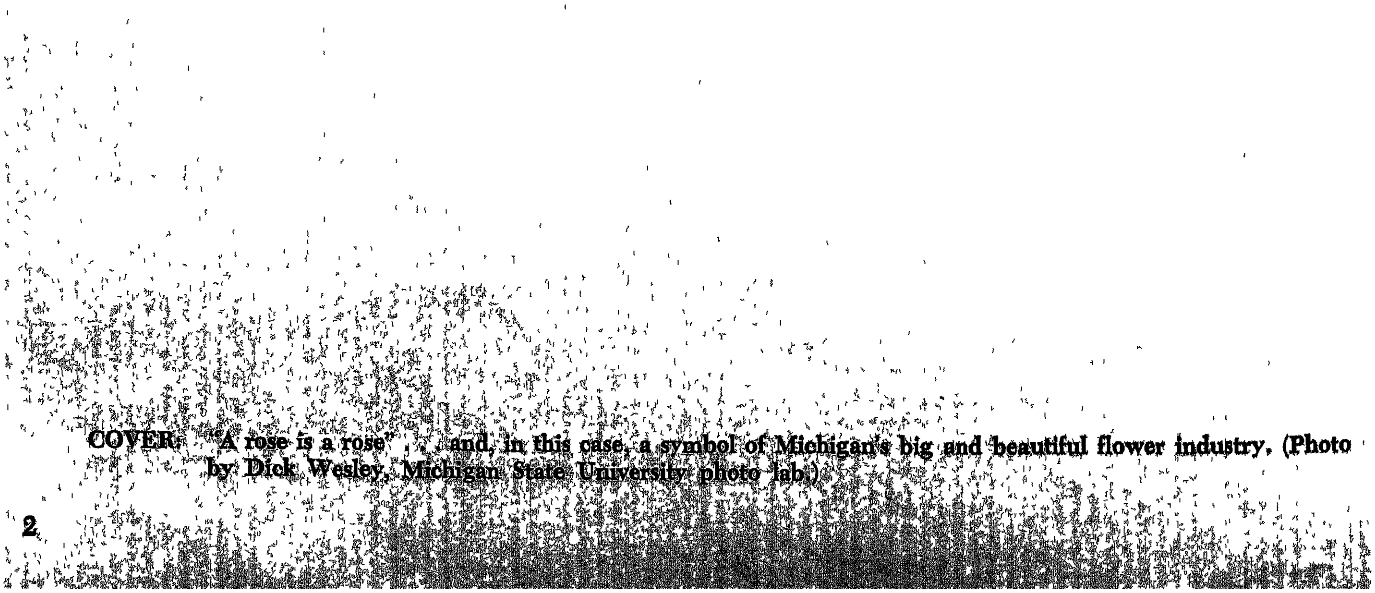
Dr. William J. Carpenter – high intensity lighting; growth regulating chemicals; flower storage and vase-life; greenhouse environment.

Dr. William H. Carlson – bedding plants; Extension specialist in general flower care for commercial growers, retailers and homeowners.

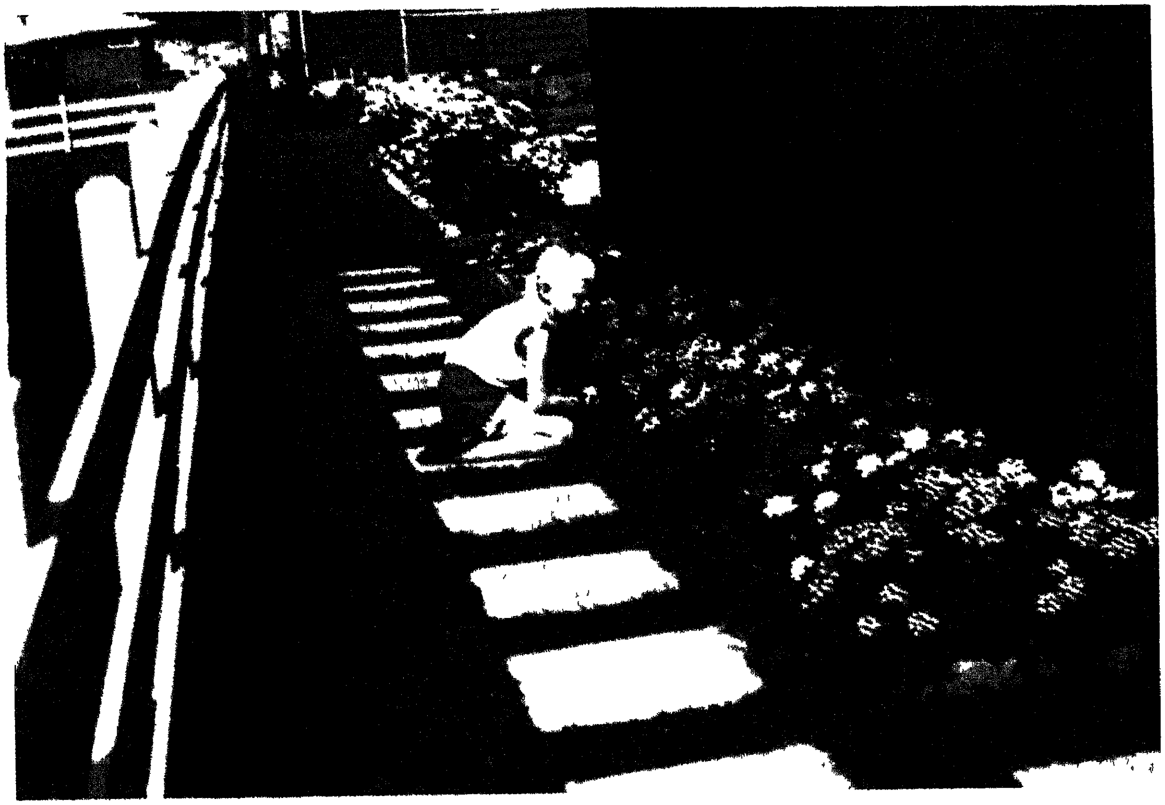
Dr. August A. De Hertogh – the physiology and biochemistry of spring flowering bulb plants.

Dr. Kenneth C. Sink – plant breeding and genetics; culture of poinsettias.

Further information is available by writing to these men in the Department of Horticulture, Michigan State University, East Lansing, Michigan 48823.



COVER: "A rose is a rose" . . . and, in this case, a symbol of Michigan's big and beautiful flower industry. (Photo by Dick Wesley, Michigan State University photo lab.)



FLOWERS are for people! Verbena, a flowering annual, and a friend.

Flowers represent a $20 million industry in Michigan. What's more, the millions of flowers grown in this state enrich all of our lives.

At Michigan State University, men and women conduct research, extension and teaching programs with enthusiasm because they feel that flower esthetics – flower power – are important.

While emphasizing their flower research, we must point out that Drs. William Carpenter, William Carlson, August De Hertogh and Kenneth Sink work more with people than plants. Last year, this research team held over 200 meetings, met with over 50,000 people and helped produce television shows, radio programs and publications for growers and consumers.

The MSU research team works this way because flowers differ from most agricultural or horticultural commodities – we can probably survive without them, but humans have a right to do more than just *survive*. And that's why MSU scientists reshape flowers and help them grow and look better.

MUMS — standard chrysanthemums—represent a $1.7 million industry in Michigan. They are especially popular for sweethearts attending football games.

The Flower Industry

About 500 professional flower growers in Michigan produce nearly 3½% of the commercially grown flowers in the United States.

Bedding plants account for almost one-third of the $20 million industry. Sales and production of these plants have more than doubled in each of the last three decades. Michigan now produces 10% of all bedding plants grown in the U.S.

Variety is the "name of the game" in Michigan. State flower growers can boast of a $2 million rose industry; chrysanthemums, about $1.7 million; perennials, $1.5 million; outdoor flowers, $3 million; foliage plants, $500,000; poinsettias, $1 million, geraniums, $1.5 million; azaleas, hydrangeas, etc., $1 million, lilies, $500,000; and cut gladioli, $500,000

The flower market potential is great. Recent MSU studies showed that 98% of Michigan consumers surveyed had a place to plant flowers; 78% had purchased some within the last year.

Commercial growers are asking consumers questions, too. They want ideas on how they might improve their product. Consumer suggestions, such as wider selection and more durable plants, have been passed on to MSU researchers. The result is an intensive effort to produce "ideal" flowers.

SOME OF MICHIGAN'S millions who like flowers bought geraniums during Flower Day at Eastern Market, Detroit.

– To grow more attractive plants more efficiently.

– To develop tailor-made flowers for consumers

These are the aims of Michigan State University researchers. Genetics are used to improve varieties, such as reshaping plants and brightening their colors and giving them insect and pollution resistance.

Researchers also work on better propagation techniques (methods of multiplying plants) so we can have thousands of plants like the ideal or near ideal parent developed through breeding and selection.

Petunia Breeding

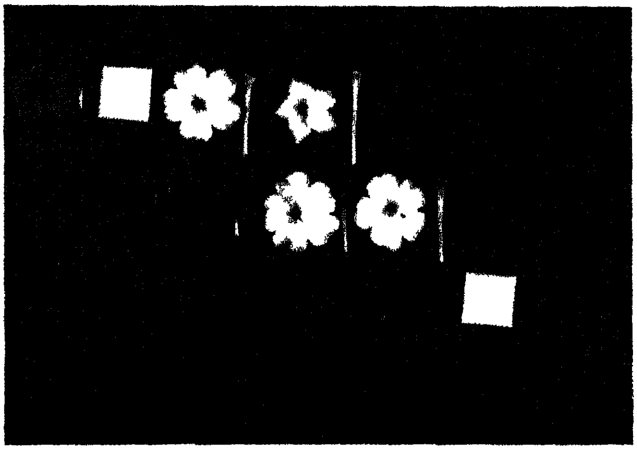
Petunias are the most popular bedding plant in the U.S. They account for 40% of the total number and about 75% of the total dollar value of bedding plants. Researchers aim to keep this popularity while increasing flower quality and improving growing efficiency.

MSU scientists found a way to reduce the cost of producing double flowered petunias – spray them with a chemical growth regulator. This upsets the hormone balance in the plant, causing it to produce single flowers instead of double ones. So the plant breeder can produce seed on double flowered plants instead of maintaining them asexually. This technique eliminates costly virus disease problems

MSU plant breeders are looking for petunias – either cultivated or wild – with disease, insect and pollution resistance that could be bred into improved varieties. About 40 to 50 wild species grow naturally in the southern hemisphere, but only a few are directly involved in the evolution of the common petunia grown in home gardens. By studying these species scientists learn to identify "good" characteristics that could be bred into improved cultivated varieties.

Genetics research is used to identify single gene characters and determine their inheritance and value in new varieties. Inbreeding is needed to get plants with good characteristics that can be crossed to produce even better hybrids which carry the best combinations of characteristics from both parents.

PETUNIA POWER – spraying with a chemical growth regulator changes some double flowers to single ones (right).



THESE WILD PETUNIAS are sources of new germ plasm for genetic and breeding studies. Scientists also study flower shape, size and vigor.

Some genotypes can be successfully inbred and used as parents in hybrid seed production Other types, also desirable parents, become weak when inbred only two generations and do not produce seed or pollen These lines are being evaluated from a biochemical viewpoint to find the causes of weakness and what can be done to overcome them.

HIGH INTENSITY (2,000 ftc) from Lucalox and Multi-vapor lamps greatly increases seedling growth (Comparison one month after sowing.)

Propagating Flowers

Once a plant breeder selects or breeds an improved flower, someone has to propagate it — multiply it before the parent flower dies. At MSU, scientists are using artificial lighting to improve rooting during propagation. They are also experimenting with chemical growth regulators that speed up rooting and cut production costs. Experiments are being conducted with poinsettias, geraniums, chrysanthemums, begonias, African violets and others.

To improve poinsettia rooting, for example, MSU researchers successfully used chemical growth regulators to increase root numbers and size. Thus, growers can more readily propagate poinsettias. Best treatment so far is a Cycocel drench at 100 parts per million (ppm) with Hormex, a rooting stimulant. This study and others at MSU show that the growth retardant most effective in controlling a plant species height (in this case, Cycocel) is also the best for increasing its rooting — if you use the proper concentration.

Best Rooting Temperature

In one MSU study, scientists found the optimum temperature for rooting poinsettia and geranium cuttings was around 77° F. They weren't too surprised to find reduced root growth if cuttings were held at low temperatures (41° to 50° F) or high temperatures (85° to 96° F) for 24 hr or more. Plants exposed to those adverse temperatures for 24 hr took at least five days to recover — even if they were given optimum temperatures after their exposure. This information could have quite a bearing on shipping and other unusual flower handling procedures in which extreme temperatures are involved.

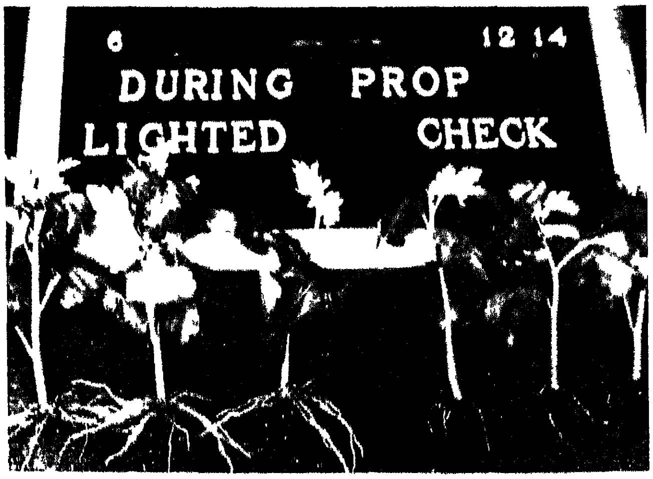
LIGHTING also speeds up growth after potting rooted cuttings. Compare lighted (left) with unlighted plant (right).

Lights Speed Up Seedling Growth

High intensity artificial lighting produces fantastic increases in flower seedling growth rates.

In MSU tests, seedlings were allowed to germinate under low light intensity - 50 to 100 footcandles (ftc) After seedlings emerged, they were placed under high intensity lighting conditions (2,000 to 2,200 ftc) around the clock. Seedlings up to 10 times as big (fresh weight) as those grown under natural greenhouse lighting conditions resulted. Experiments worked on zinnias, chrysanthemums, geraniums, marigolds, petunias, snapdragons, cinerarias, calceolarias and greenhouse tomatoes.

For more details on the kinds of lighting used, see "Light Turns on Roses" page 12



HIGH INTENSITY lighting also speeds up chrysanthemum rooting and growth. (Comparison 10 days from cuttings.)

Michigan State University scientists are making impressive advancements in their efforts to improve the environment and growing practices for flowering plants. Experiments in this area change from year to year as research is directed toward the most critical problems facing consumers and the commercial flower industry. The following are progress reports of current projects.

Growing Medium: Key to Plant Growth

A good growing medium is the most important step in plant production. The ideal soil mix should be sterile (free from insects and diseases), well-drained, low in soluble salts, adequate in fertility, free from toxic materials, able to hold moisture and nutrients, light weight and inexpensive to prepare

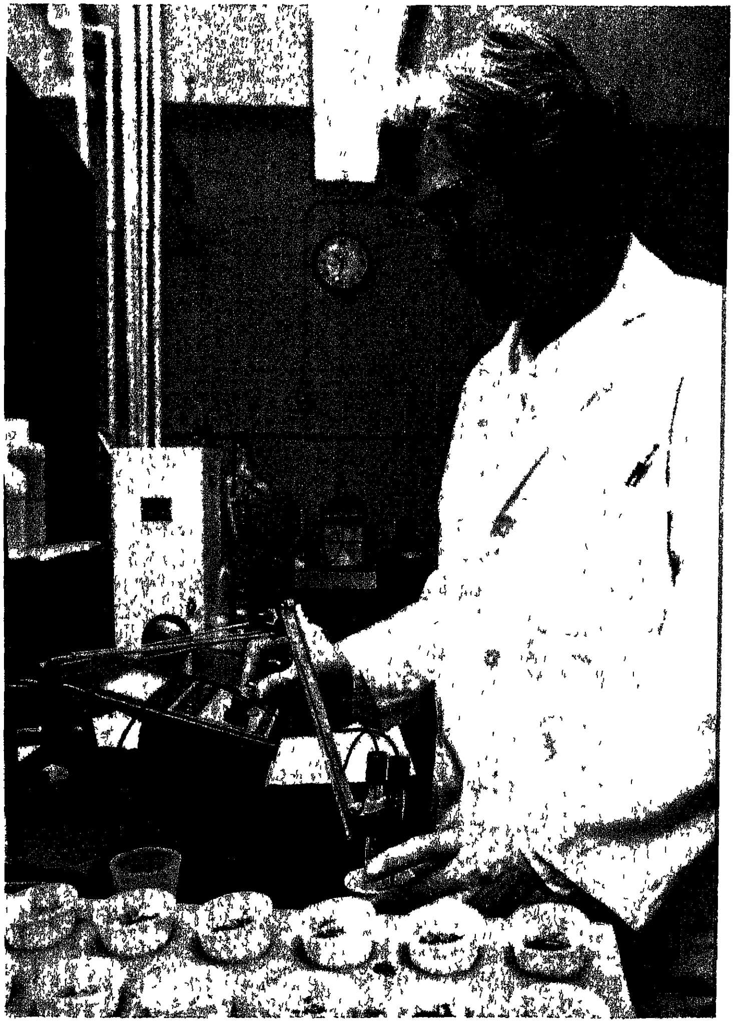
For growers using a completely synthetic mix, sterilization isn't necessary. Examples of these mixes are peat and perlite or peat and vermiculite mixed together at a 1 to 1 volume ratio (not weight).

But sterilization is needed if you add soil to the mix For commercial growers, steam is the best method; 180° F for 30 min. will destroy all harmful fungi, bacteria, insects and weeds in the soil. Home gardeners should put the soil in an oven at 180° for 90 min.

Soil Testing Service

More than 500 greenhouse soil samples are analyzed each year at the MSU Soil Testing Laboratory in the Department of Crop and Soil Science Then, experts from soil science and the Department of Horticulture add specific recommendations for flower growers

Recommendations include type and amount of nitrogen, phosphorous, potassium, calcium and magnesium. Growers also get information on soluble salts, degree of acidity or alkalinity, etc. The idea is to achieve efficient flower production with optimum *fertilizer applications*



SOIL TESTS for homeowners and commercial growers are run in Michigan State University's Soil Testing Laboratory. Here, Mrs. Florence Drulinger, technician, runs tests for soil pH (acidity). Cost for a basic soil test is $3; for a greenhouse test, $4, as more analyses are run The MSU lab handles more than 2,000 tests for homeowners and another 15,000 for farmers each year

PETUNIAS, the nation's most popular bedding plant, brighten the landscape.

Better Fertilizers

Slow release fertilizers boost flower growth for commercial growers and provide continued nutrition for plants after they are purchased by consumers.

MSU tests show that Osmocote and other slow release fertilizers, if mixed with soil in the greenhouse, are highly effective for growing plants. Other slow release fertilizers like MagAmp supply *nitrogen, potassium, phosphorous and magnesium* for soil deficient in these elements.

Specific recommendations for slow release fertilizers are available from MSU's Department of Horticulture.

Better Bedding Plants

Bedding plants are annual flowers grown from seed. Historically, this meant a lot of hand labor for Michigan commercial growers who produce one out of 10 bedding plants grown in the United States. By improving cultural practices, MSU researchers can minimize hand labor and pass the savings on to consumers.

For example, many growers must seed their plants early in the winter to have enough time for hand transplanting. But MSU scientists are evaluating direct seeding techniques that could greatly reduce hand transplanting.

Improved bedding plant storage techniques are also being developed. MSU tests show, for example, that certain bedding plants can be held a month if storage units are kept at 32° F. Growers can then hold some seedling varieties at different growth stages for transplanting at a more convenient time.

MSU researchers demonstrated that several herbicides effectively control weeds without damaging the plants Contact your county Cooperative Extension Service office or the Department of Horticulture, Michigan State University, for the latest weed control recommendations.

Additional information on bedding plants is available in Science in Action #7, *Bedding Plants· Michigan's Blooming Industry.* Write the Bulletin Office, Box 231, East Lansing, MI 48823.

"Programming" Lilies for Easter

Because Easter falls anywhere from the fourth week in March to the third week in April, "programming" lilies so they bloom at Easter isn't easy. In the past five years, MSU researchers have developed a forcing technique which combined the best of two previously existing techniques.

Called controlled temperature forcing (CTF), it causes lilies to produce about 30% more flowers than those grown by commercial precooling. Here's how it works: Easter lilies, shipped to Michigan in October direct from fields in Oregon or California, are planted in pots and allowed to grow at 63° F for 2 to 3 weeks. Next, they are cooled for six weeks at 35° to 40° F. Then they are placed in the greenhouse and forced.

The key to the CTF method is the 2 to 3 weeks of growing before chilling the plants. This differs from

"natural forcing" in which lilies are placed in unheated greenhouses and cold-frames in October, and nature "programs" the bulb. It differs, too, from the "precooling" technique in which lilies are put directly in coolers for six weeks, after they've been shipped from the fields.

In all of these forcing techniques, the chilling treatment acts like winter and will give the plant just enough spring-like temperatures in the greenhouse to flower

Because the Easter lily ranks second behind poinsettias in popularity as a holiday pot plant, MSU has established an intensive Easter lily research effort. MSU scientists are trying to improve techniques to help growers time their flowers with Easter. They also want to produce more ideally shaped plants (Christmas tree shaped or columnar) so consumers will get a more attractive, compact plant

MSU scientists are also studying the two types of flowers produced by the lily – primary and secondary – to find out what controls the development of these flowers so that more can be produced per plant. Primary flowers are produced from the apical meristems (top of the stem), and the secondaries in the axils between the primary flowers and the bract leaves Theoretically, each primary flower could produce a secondary one, but not many lilies do this. MSU researchers want to find out why, so they can get them to produce at full flower potential.

Experiment Station scientists have also obtained data on the proper temperatures for lily root development and the effects of gibberellins on the plant and its flowers They know gibberellins can keep secondary flowers from forming. By controlling these and possibly other hormones, scientists think they can increase flower production per plant

MSU researchers were also the first to study lily meristem development with the scanning electron microscope. This basic research technique is now used throughout the world

MEASURING EFFECT of gibberellic acid on lilies. Note reduction in flower numbers in plant on right as compared to untreated plant on left.

CONTROLLED TEMPERATURE FORCED (CTF) lilies are viewed by flower industry visitors in MSU's Plant Science Greenhouse.

SOME 200 TO 300 TULIP and hyacinth varieties have been evaluated at MSU.

MSU scientists have rewritten the book on how to force bulbs (getting tulips and other bulb plants to bloom any time of the year).

The "book" is the *Holland Bulb Forcers Guide.* It contains up-to-date information on standard forcing techniques for tulips and hyacinths, including preplanting, handling, rooting, greenhouse operation, disease and insect control, harvesting, storage and marketing. The looseleaf, illustrated publication, is revised annually and will eventually include narcissus, crocus and other spring flowering bulbs.

And MSU scientists are adding to the knowledge on basic and applied bulb research. Results include·

– Improvements in rooting room structures and systems by MSU agricultural engineers.

– Basic research information on growth hormones and how they affect the forcing cycle. This includes studies on terpene biosynthesis and of bulb tissues that synthesize compounds which influence plant and bulb growth.

– Applied, practical research findings for shipping, storing, forcing and marketing bulb varieties.

Research has helped MSU scientists to determine proper temperatures for efficient precooling, preplanting storage, root and shoot growth control and optimum greenhouse growing conditions.

Inside the Tulip

MSU reseachers have identified the location of gibberellins (chemical growth regulators) in tulips. They found that the tulip flower accumulates these hormones. Also, they have isolated some enzymes of the biosynthetic pathway of these hormones The rate of plant growth could be regulated by controlling this pathway. This would greatly aid greenhouse operators who force tulips.

Bulb Shipping

Ventilation during shipping helps keep flowers fresh by lowering the ethylene concentration in shipping containers. Without ventilation, ethylene given off by diseased plants or other sources can build up inside the container and cause flower bud abortion in the tulip Applying protective fungicides before shipping helps minimize either ethylene production or bulb response to ethylene.

"ESKIMO TULIPS" – Mrs. LuAnn Kent, secretary, MSU Department of Horticulture, holds plants that bloomed in October after being frozen for eight months.

"Eskimo" Tulips

"Eskimo" tulips bloomed in early October 1971 at Michigan State University after being frozen since January.

As MSU scientists explained it, "We just postponed spring until fall arrived." Now the MSU research team is well on its way to having blooming tulips all year round, greatly increasing the market potential for cut tulips. The life of these tulips is about the same as normally forced tulips – about five days, depending on variety.

"Eskimo" tulips are planted in late fall, then allowed to root under "controlled environment" conditions. Once they are fully rooted, they are covered with wet peat and slowly frozen solid in a deep freeze (25° F) in January. The frozen plants are then wrapped with polyethylene to prevent dehydration. They are misted once a month to get enough moisture to survive. In mid-September, or at anytime during the fall, the plants can be placed in an outdoor forcing area or greenhouse with temperatures cool enough to force them to bloom. They will flower in about two weeks.

Light "Turns On" Roses

High intensity lighting is used to more than double flower production of roses during the fall, winter and early spring without losing any flower quality.

MSU researchers use special lights that give off 2,000 to 4,000 ftc of light intensity for 24 hr a day to increase plant photosynthesis. Lighting not only doubles flower production, but also accelerates plant growth by 10% to 15%, causes the roses to produce more branches, more blooms and superior plants.

In MSU greenhouses, scientists are using a combination of Lucalox (an orange and red light) and Multivapor (mostly blue light) They've also been successful with Wide Spectrum Gro-Lux, florescent tubes that produce mostly blue and red light.

These artificial lights work better than natural winter sunlight for two reasons. First, they give the plant more light. Without artificial light, the plants would get only about 300 ftc of light on cloudy days and 2,000 to 5,000 on sunny days in the winter – and this is only for a relatively short time (during daylight hours) Second, winter light is mostly blue light. The plants need orange, red and blue for photosynthesis. Plant leaves sift red and blue from sunlight to grow.

So, MSU scientists are giving the plants a higher percentage of usable light. And they are using light sources 3 to 4 times more efficient than the incandescent lights used in the home.

MSU SCIENTISTS are using a combination of artificial lights to give plants a higher percentage of usable light. These high intensity Lucalox lights accelerate plant growth and double flower production.

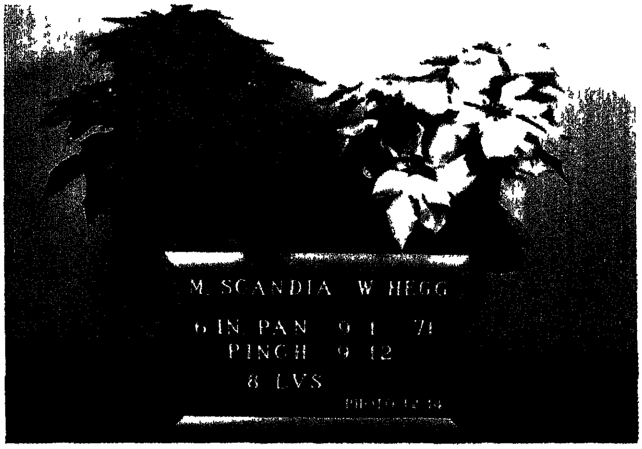
POINSETTIAS – Michigan's million dollar Christmas favorite.

Long and Short of Poinsettias

MSU researchers are looking for the best combination of cultural practices to make poinsettia growing as efficient as possible. So far, they have produced everything from "miniplants" 4 in. high to some over 2 ft tall.

Currently, scientists are testing several chemicals that stimulate root initiation. They hope to find the optimum environment for rooting With present practices, growers have to start the poinsettias in a rooting container, then transplant the rooted cuttings into the pot in which they are sold. MSU scientists are trying to find the best combination of variety, chemical and timing to eliminate time consuming repotting and the need for growing plants in a rooting container. This direct rooting procedure can be used for single stem or multiflowered plants.

Another phase of research involves precision pinching, snipping off plants to allow the growth of an exact number of shoots, each of which will produce a bloom. Researchers are working with a number of free-branching varieties to control bloom numbers. By using chemical growth regulators and potting the plants at different times, they can control plant size, number of flowers and have poinsettias in bloom anytime from Thanksgiving to Christmas



PRECISION PINCHING stimulates leaf and bloom production of poinsettias. MSU researchers are determining the best time to perform this operation.

Growth regulating chemicals are being tested at Michigan State University to reshape plants Results have included more compact plants, earlier flowering and more branching which produces a fuller plant and more cuttings for propagation. Here are some results of recent experiments·

Poinsettias

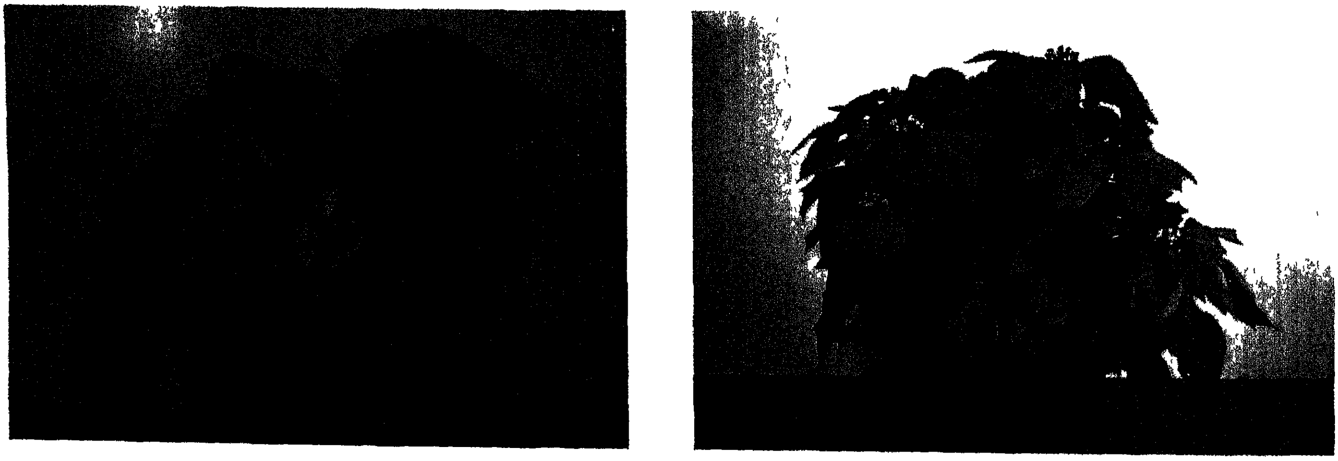
Plant growth regulating chemicals are helping poinsettia growers produce better plants with more flowers, more branches and more leaves, without pinching, thus saving the grower a task he now has to do by hand.

MSU researchers found that spraying plants with cytokinins (a chemical usually found in plants) changes the normal growing habit of the plant Normally, plants exhibit what scientists call "apical dominance." This means the main stem grows but the lateral branches are inhibited.

Until now, growers had to manually break off the top of the main stem to keep the plant compact and stimulate lateral branch growth. In so doing, poinsettia growers lost the best and biggest flowers.

By spraying poinsettias with cytokinins, the natural effect of apical dominance is temporarily lost allowing some lateral branches to develop After the cytokinin wears off, the growth of the terminal and lateral branches continues. The plant then produces the same big flower it would if allowed to grow naturally but with added lateral branch-borne flowers. This gives more branches, more flowers, and more leaves, so growers get an attractive, compact plant.

MSU tests show the cytokinin PBA works best, but another, BA, also shows promise.



POINSETTIA on left was sprayed 10 days ago with PBA, a chemical growth regulator, at 200 ppm. Thus, the flowering plant (right) developed lateral branches without time consuming hand pinching of the terminal stem.

GERANIUM IRENE treated with high intensity lighting for six weeks (left) flowers earlier and produces more flowers on branches.

ETHEPHON stimulates branching and produces more compact geraniums. In MSU tests, plants averaged 12 branches per plant, 3 to 5 more than plants treated with other growth regulators.

PETUNIA on left was treated with BA (growth regulator) at 200 ppm. Note more extensive branching.

Geraniums

Production of geranium cuttings can be substantially increased using growth regulators. And the best one so far in MSU tests is Ethephon (Ethrel).

In recent years, Ethephon produced a more compact, desirable plant than most other growth regulators tested. Better yet, it produced plants with an average of 12 branches per plant—3 to 5 more than other chemicals tested. This means growers have more cuttings for potting and producing plants for sale.

Earlier MSU studies showed that growers can produce standard tree-like geraniums in 4 to 6 months instead of 12 to 15 by spraying them with gibberellic acid. The growth regulator also increased flower size and extended flower life Growth regulator sprays, plus good cultural practices and fertilization, insure efficient production of desirable plants.

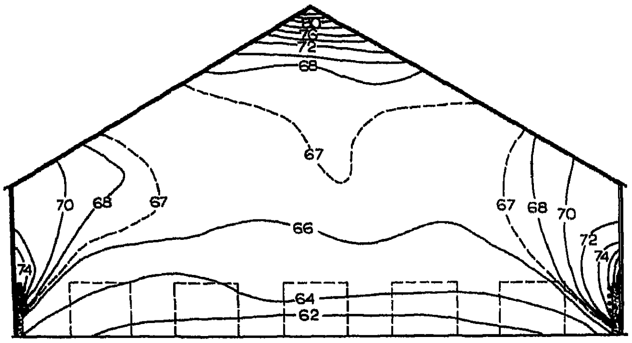
Petunias

One of the best growth retardants for petunias is B-9 Commercial growers are producing short, compact plants by spraying the petunia seedlings with 2,500 to 5,000 ppm of B-9 when the plants are the size of a half dollar

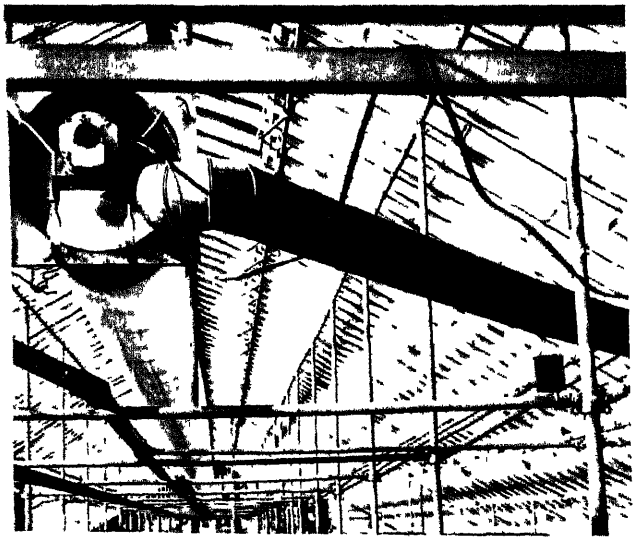
A promising new growth retardant for producing compact petunias is "Arest" MSU tests show that the growth regulator keeps petunia plants compact by shortening the internodes and thickening the stems without delaying flowering This means a shorter, more branched plant that will produce more flowers and have darker green foliage. It must be used at much lower concentrations than other growth retardants because its effective period is eight weeks after treatment compared to 3 to 4 weeks with the growth regulator B-9. Further studies will be made to provide more information on the use of "Arest" on a commercial basis

Chrysanthemums

The cytokinins BA and PBA have also been effective on chrysanthemums, significantly increasing branching, BA also produced a more compact plant Details of this study, including application rates and other chemicals tested, are available from MSU's Department of Horticulture.



GREENHOUSE TEMPERATURES vary during heating with location and type of heating system used in greenhouses. This diagram shows temperature patterns where steam pipes are mounted on greenhouse sidewalls.



GREENHOUSE OPERATORS install extensive heating and air circulation systems to maintain uniform temperatures for optimum plant growth and quality.

Air Circulation

MSU researchers tested different techniques for measuring air circulation patterns during greenhouse heating. They found that these patterns vary with the location and type of heating system. Many growers have air circulation that may interfere with the temperature pattern of greenhouse heating systems.

In studies of greenhouse heating with overhead steam coils, researchers reported that heating pipes are needed at plant level to maintain a uniform heat balance between air and plant temperatures. The pipes can be placed along the side walls of ground beds or beneath raised benches MSU scientists estimate that growers need only one-third to one-fourth of the pipe at this location for more uniform temperatures.

The study also showed that placing heating coils overhead creates higher temperatures near the roof, increasing fuel costs and square feet of pipe surface needed to heat the greenhouse. Some growers might consider this cost worthwhile, however, because this location makes greenhouse operation more convenient than a plant-level system.

MSU scientists also found that unit heaters with attached convection tubing satisfactorily heat greenhouses. However, the heat should be continual to keep a warm canopy of air above plants and prevent rapid heat loss by radiation that occurs between heating cycles.

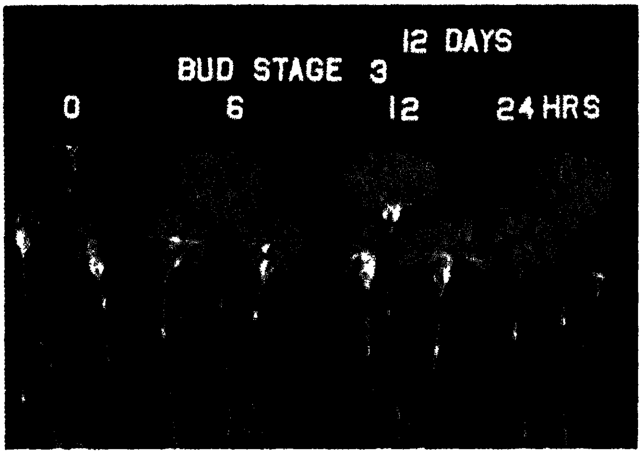
Temperature

Temperature differences at plant level can vary 12° to 15° F from one part of a greenhouse to another, unless heaters are properly located and a good air flow is maintained.

MSU researchers found that with two heaters developing a circular air flow, temperature variations can be reduced 8° to 10° F. A modulating heating system, which varies the heat supply through a number of step levels, plus constant air flow, can nearly eliminate temperature variation.

Few unit heaters have modulating valves to govern their output, therefore, heater fans should run all night long when heat is needed. The fans maintain a circular air flow pattern in the greenhouse keeping temperature distribution more uniform.

MSU studies show large greenhouses (100 to 200 ft long) can be heated uniformly with horizontal discharge unit heaters if a single air circulation pattern is developed to encompass the entire greenhouse at plant height.



CUT CARNATIONS treated with experimental chemical (TH 6241) plus a floral preservative will last 30% to 40% longer than untreated carnations. Note that after 12 days, the untreated flowers were dead, while those receiving 12-to 24-hr treatments were still going strong.

Attempts to increase the life of cut flowers go back thousands of years. Palladius in 350 A D in his publication "De Re Rustica" devoted a chapter to storing green roses. Since then, hundreds of experiments have been conducted to show the effects of natural and artificial cultural practices on extending vase-life.

At Michigan State University, scientists have not tried to change commercial practices for extending vase-life. Instead, they have tested various chemicals and techniques to see what can be *added* to current methods so that vase-life might be extended even further.

Preservatives Plus Chemicals

The vase-life of carnations and roses is increased by 30% to 40% by immersing the flower stems in a solution containing an experimental chemical (TH 6241) and a floral preservative for 12 to 24 hr. Then, the flowers are put into the floral preservative alone.

MSU researchers believe this chemical will be released for commercial use soon and that their procedure will be widely adopted by commercial flower producers. The technique is inexpensive (only 5 ppm of the chemical is needed), and can be performed by the flower producer. So, the the consumer will get all the benefits with no effort and probably no additional expense.

This chemical (TH 6241) prevents the early termination of a flower's life by preventing ethylene buildup, a natural by-product of plant respiration.

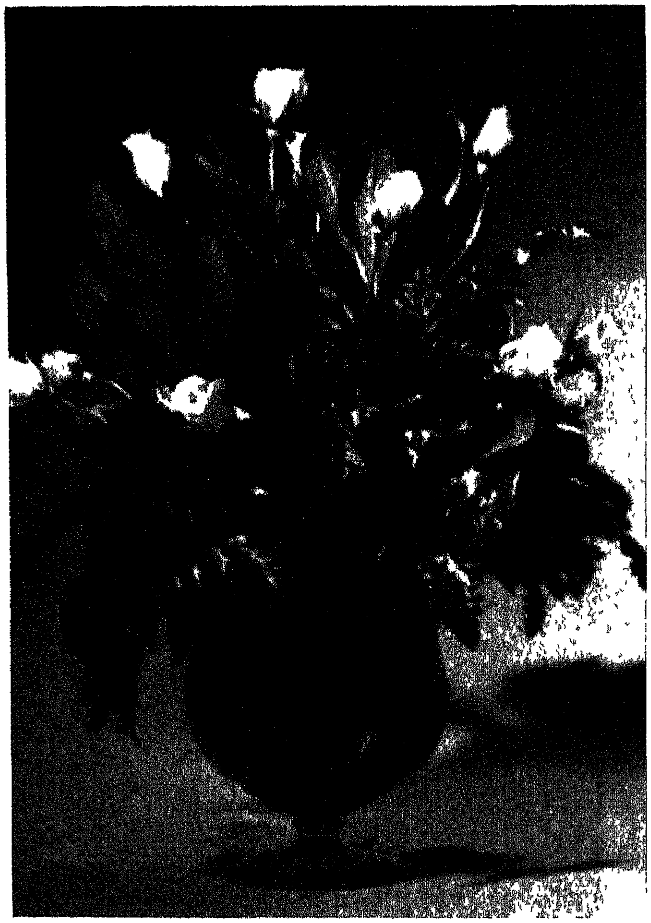
Keeping Cut Carnations? Cool Them

Cut carnations can be kept in "suspended animation" for six weeks without shortening their vase-life.

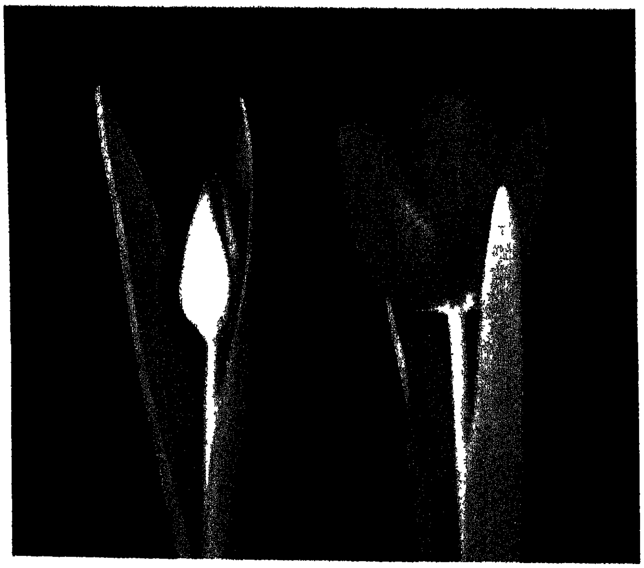
The trick is to store them in a unit that combines refrigeration at 32° F and reduced atmospheric pressure to 1/20th of normal levels. When taken out of the storage unit six weeks later, the carnations are in the same condition as if they had just been freshly cut.

Low pressure storage (LPS) works because it minimizes the effects of ethylene. In a partial atmosphere, the ethylene diffuses from the plant tissue very rapidly, so the effect of the gas on the plant is minimal.

This research began in the summer of 1971, but looks very promising for practical, commercial floriculture use on several flower crops.



FLORAL FOAMS help extend vase-life and can be used to improve many floral designs.



FLOWERS, bought in the bud stage, (left) will last longer and produce a larger flower (right).

Soda-Pop Works!

The most unusual – but effective – flower preservatives tested were Sprite and 7-Up. According to MSU horticulturists, the citric acid and carbonation in the soft drinks control the development of microorganisms that can block water-conducting vessels of rose stems and reduce firmness. Sugar in the soft drinks sustains life They recommend mixing one part water with each part soft drink and adding a half teaspoon of chlorine bleach to each quart of solution The bleach cuts bacterial growth.

So Do Floral Foams

Another MSU study showed that floral foams, used by retail florists for improving floral designs and handling ease, help extend vase-life Researchers noted, however, that foams and their effectiveness vary because they have been developed for various uses. Some have high water holding capacity and can hold adequate water with stems as far as 8 in. above the water reservoir. Others work only when stems are submerged in water as the manufacturer recommends But the research shows that many of today's floral foams are more than flower holders, they extend rose life and supply enough water for flower stems to be inserted well above the water reservoir in the vase.

A Tulip Is a Tulip?

No, tulips aren't all the same when it comes to vase-life MSU scientists evaluated post-harvest characteristics of over 100 varieties and found that vase-life can vary from as little as 3 days to more than 6.

Researchers noted variations in quantity of water absorbed by different varieties and that stems and flower petals continue to elongate after cutting.

Information from this study has been made available to the tulip industry as a guide for developing better, longer-lived flowers.

Other MSU publications on Horticulture and related fields.
Research Reports

RR-62	Use of Fumigants and Clear Plastic Mulch on Muskmelons
RR-69	Preharvest Spray Cooling for Tart Cherries
RR-73	Maintaining Quality by Brining Sweet Cherries after Harvest
RR-85	Chesibb–A New Butterhead Lettuce for Greenhouses and Outside
RR-87	When to Harvest Sweet Cherries Mechanically
RR-88	Fruit Removal and Quality of Mechanically Harvested Sweet Cherries
RR-126	Rapids–Greenhouse Tomato Resistant to TMV
RR-135	Green Ball–A New Type of Cauliflower
RR-138	Droplet–A New Fresh-market Tomato
RR-140	Techniques for Improved Weed Control Efficiency in Cucumbers
RR-162	Frommage–A New Processing Pepper
RR-163	Domineer–A New Greenhouse Lettuce
RR-165	Trickle Irrigation–The Concept and Guidelines for Use

Extension Publications

F-122	Pruning Young Fruit Trees
E-154	Fruit Spraying Calendar
E-347	Pruning Grapes
E-509	Peaches (Culture in Michigan)
E-516	Peats for Soil Mixes
E-519	Pear (Culture)
E-521	Strawberries in the Home Garden
E-532	Harvesting Machines (Cherries)
E-533	Growing Apricots in Michigan
E-542	Raspberry Culture
E-564	Hints on Growing Blueberries
E-590	Essentials of Blueberry Culture
E-593	Forcing Spring Flowering Bulbs
E-595	Apple Scab Control
E-596	Cherry Leaf Spot Control
E-598	Commercial Production of Asparagus
E-627	Jonathan Quality and Storage Life
E-646	Lawn Care
E-654	Tart Cherries (Good Quality)
E-659	Cooling Stations (Cherries)
E-660	Tart Cherries, Mechanized Harvest Systems
E-673	Lawn Establishment
E-675	Commercial Grower Recommendations (Vegetable)

Single copies of 10 of these publications are available by writing to:
MSU Bulletin Office, P.O. Box 231, East Lansing, Mich. 48823

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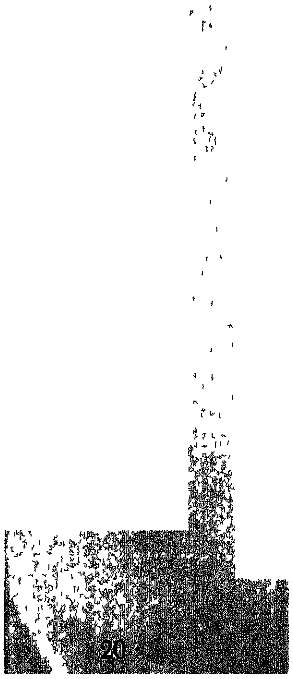


michigan SCIENCE IN ACTION

FROM THE MICHIGAN STATE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION, EAST LANSING
AUGUST 1972

20 Focus on Child Development at MSU

Dr. Robert Boger — Director of the Institute of Family and Child Study; professor Family and Child Sciences

Jeanne Brown — instructor and extension specialist, Family and Child Sciences

Dr. Eileen Earhart — assistant professor and curriculum specialist; Family and Child Sciences

Dr. Hiram Fitzgerald — associate professor, Psychology

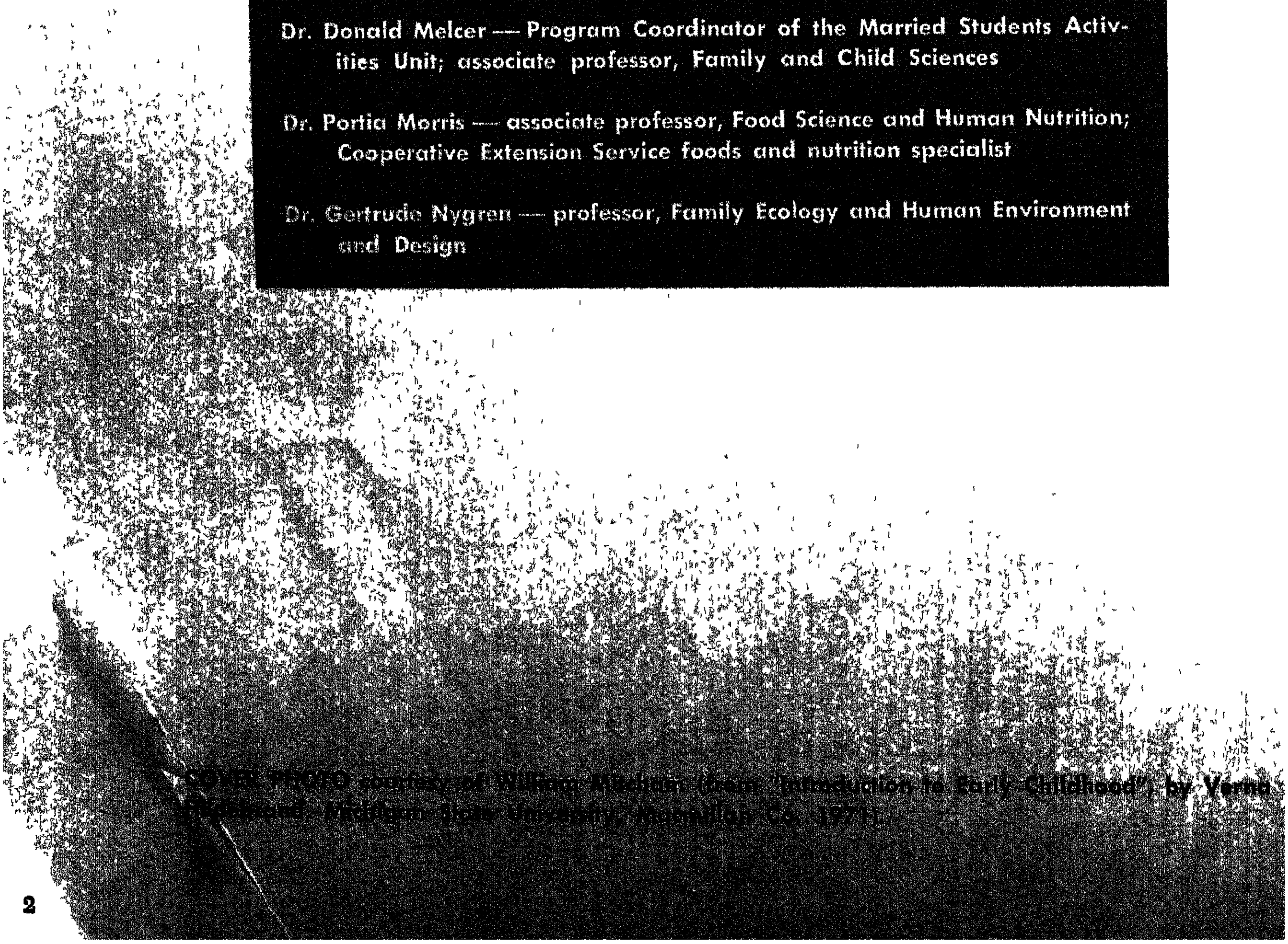
Dr. Verna Hildebrand — associate professor, Family and Child Sciences and Family Ecology

Dr. Judith Kuipers — assistant professor, Child Development and Family Relations (Colorado State University)

Dr. Donald Melcer — Program Coordinator of the Married Students Activities Unit; associate professor, Family and Child Sciences

Dr. Portia Morris — associate professor, Food Science and Human Nutrition; Cooperative Extension Service foods and nutrition specialist

Dr. Gertrude Nygren — professor, Family Ecology and Human Environment and Design



COVER PHOTO courtesy of William Mitchum (from "Introduction to Early Childhood", by Verna Hildebrand, Michigan State University, Macmillan Co. 1971).

To meet the need for human research with immediate social relevance, an Institute for Family and Child Study was formed in July, 1970, at Michigan State University. The new unit was organized to encourage and expedite interdisciplinary study in the areas of family life and child development. Dr. Robert Boger was appointed its initial Director. Although an administrative unit of the College of Human Ecology, the Institute cooperates with the Colleges of Social Science, Education, Human Medicine and the Counseling Center in research.

One of the major funded research efforts of the Institute is the Early Childhood Research Center. Supported by the Office of Economic Opportunity, it helps develop significant pre-school curricula and related research Researchers view the family unit as a building block of society, and have initiated programs in housing, parent/child relations and family nutrition.

Two major support units of the Institute lend needed aid to Human Ecology research efforts. Next to the campus television station, the video support unit conducts more hours of videotaping than any other in the University. The data analysis support unit provides consultation services in research design and analysis.

Whenever possible at MSU's lab, pre-school children are "taught from behind" so they're less distracted by the adult. Faucets offer only lukewarm water, so a child can learn to manipulate the hardware without worrying about hot and cold. (Photo by Paul Rochlen)

The Married Students Activities Unit at Michigan State University accommodates infant, toddler and pre-school day care classes.

MSU's Married Student Activities Unit (MSAU) is a part of the Institute for Family and Child Study. This new modular unit accommodates infant, toddler and pre-school day care classes; it also deals with family *and* student problems.

"Student families often operate under a 'prison syndrome,'" says Dr. Donald Melcer, MSAU program coordinator. "They live for the time they will be out. Family concerns are deferred to some future, 'easier' time."

"But, if family members live for 3 or 4 years without developing personal relationships, chances are good that they never will," he says. "The MSAU philosophy stresses that family life is *right now*, that children, in particular, are unable to defer emotional needs 'til later."

The MSAU is an interdepartmental effort, drawing board members from the MSU Departments of Psychology, Human Ecology, and Human Medicine, the Counseling Center, School of Social Work, and from the married student body.

Volunteer faculty members conduct problem solving programs dealing with child care, marriage and parent/child enrichment, single parents and family finances.

MSU's Child Development Program has become a statewide effort, thanks to Experiment Station research and the efforts of the Cooperative Extension Service.

Expertise is now being extended by campus specialists, plus 70 Extension Home Economists and about 200 aides in Extension's Expanded Nutrition and Family Program. Programs are being developed for children, teachers and parents. In-service training is available to anyone taking care of children. According to Jeanne Brown, Extension child development specialist: "This means we work with day care centers, nursery schools, churches, with foster families and so on."

One thrust of MSU's Child Development Program is centered in a northern, Black rural community which had become a poverty pocket. Mrs. Brown and experts from the Department of Resource Development recently tried to upgrade the day care center in the county while encouraging support for the center in the community. Additional help was sought from the Extension Service and the Michigan Department of Social Services.

"We do not go to counties like this to ask them for something," says Mrs. Brown. "We try to give them whatever guidance they want."

Kids are getting all kinds of help from home economists and aides in MSU's Cooperative Extension Service. Research to support Extension child development programs comes from MSU's Agricultural Experiment Station. (Photo by Paul Rochlen)

"Quality care" is a key term in MSU's Infant and Toddler Day Care program, a branch of the MSAU and Institute for Family and Child Study.

According to program director, Dr. Hiram Fitzgerald, and Kathy Baxter, supervising teacher, the first 2½ years of a child's life are critical for shaping growth mechanisms and personality development.

"We want to provide a warm, loving, consistent environment where a child can be comfortable; where he feels free to participate and explore," Dr. Fitzgerald says.

"There are all kinds of curricula for the pre-schooler in this country," he says. "But infants and toddlers are different from pre-schoolers. They have distinct and specific needs. If a child is emotionally 'lost' at age three, he's likely to be lost forever. Emotional development is the major concern of all our programs."

The 2½-year-old infant-toddler unit serves the children of MSU students. It employs a full-time pediatric nurse and a Family and Child Science specialist. About 40 undergraduate psychology and child development trainees work there now. However, the Center will soon draw trainees from other departments and major disciplines.

Four infant and toddler programs are conducted based on a weekly schedule. Each program is interspersed with free play periods.

The *sensory training program* allows infants and, later, toddlers to experience shapes, sounds, textures, etc. through self-initiated activities. *Attention and language training* aims at interpersonal development. Student teachers act as a catalyst — not an answer — to building a sense of curiosity and discovery.

Each child's *physical education* is supported by a total massage and reflex strengthening exercises. This assures that each infant receives the stimulation of being touched and, later, that he develops appropriate motor skills.

Solitude is an important program providing *relief* from stimulation. In the "real world," Mom is often too busy to play, and a child is left alone to sort out his experiences. At the Center, he is given time to play, sleep or contemplate his world without adult involvement.

"Infant and toddler day care units are a great convenience for working mothers, but our primary concern is the welfare of the child," Dr. Fitzgerald explains. "We allow each child to develop at his own speed in a nurtural atmosphere. As for specific kinds of opinions and attitudes, we have no desire to replace those of the parents."

Every child, adolescent and adult needs certain spaces and objects they can claim as their own. Ownership and privacy are two important parts of healthy social relationships. (Photo by Paul Rochlen)

A rocker is a great place for storybook learning. With a child on his lap, an adult can touch the child and guide his attention without being, himself, a diversion. (Photo by Paul Rochlen)

Every child needs time alone with himself to think about all that's happening and to act on the world. Here, a full-length, "kid-level" mirror provides the perfect prop. (Photo by Paul Rochlen)

Physical education for infants and toddlers combines tactile experiences with development of fine and gross motor skills. A climbing game encourages tots to make the best use of their legs, arms and balance. (Photo by Paul Rochlen)

Building Social Skills

Dr. Boger, Miss Jo Lynn Cunningham and a research team from the Institute of Family and Child Study are completing a 3-year program to assess the social behavior of pre-school children, and to develop a curriculum for increasing their social skills.

No one is immune to the social forces that shape an individual's behavior. The staff of this project believe an effective socialization curriculum for 3- and 4-year-old nursery school children will build self-esteem, self-control and tolerance of others to last a lifetime.

The socialization lesson plan includes activities between two children, group activities and dramatic play. These lessons encourage the child's willingness to initiate tasks, curiosity, innovative behavior, task persistence and cooperation.

In the dyadic play situations, pairs of children learn to play together to reach a common goal. The group activities teach self-control and tolerance. Children from diverse backgrounds, with diverse behavior and communication styles, learn to interact positively. Specially designed dramatic play also helps develop these social skills.

This program is a 2-year experiment, following the subject children from 3 to 4 years of age. Baseline measures were taken, and the study was made a part of each child's pre-school experience.

Special instruments were developed to measure the children's behavior, primarily in a free-play setting, but also interacting with one parent. Observations show that social class (including income level, parental education, occupation and housing), greatly influences the way children interact — more so than sex and race.

Group activities require cooperation and the sharing of turns. Sitting on the floor with her students, a teacher can introduce new songs, rhythms and finger games. (Photo by William Mitcham)

In free dramatic play situations, children use available props in ways they've watched adults use similar items. This imitative play is often combined with the creative content of their "dramas and helps them understand one another." (Photo by William Mitcham)

Building Learning Skills

What activity is more important and pervasive in our lives than recognizing and classifying information? From birth, we are met with a barrage of stimuli that never quits. Plants, animals, toys, television, books, other people all demand attention.

Systematic training in attention and classification skills must begin in early childhood to be most useful in learning situations. Dr. Eileen Earhart has developed a training manual for kindergarten teachers. It consists of 40 lessons designed to help the young child develop his thinking skills. The lessons are divided into three units of increasing difficulty — Exploration, Attention and Classification. Language training — encouraging the child to express himself — is stressed throughout the program.

In the Exploration Unit, the child manipulates new materials by using his hearing, sight and touch. Block, pegboard and felt board games introduce color, size, form, texture and use.

In the Attention Unit, the child observes objects and pictures, identifying likenesses and differences.

The Classification Unit is the most difficult. The child describes and compares categories such as fruit, vehicles, clothing and animals. He is encouraged to rearrange the categories according to characteristics of form, color, size, function, etc. Teachers are urged to accept unusual groupings when the child gives a good reason for his choice.

These lessons are planned for a small group of children. This way, each child benefits from the teacher's attention and praise.

Many children enter school eager to learn, but become disillusioned by failure. Too often, they receive help only *after* they become reluctant to learn, convinced of their own inadequacy.

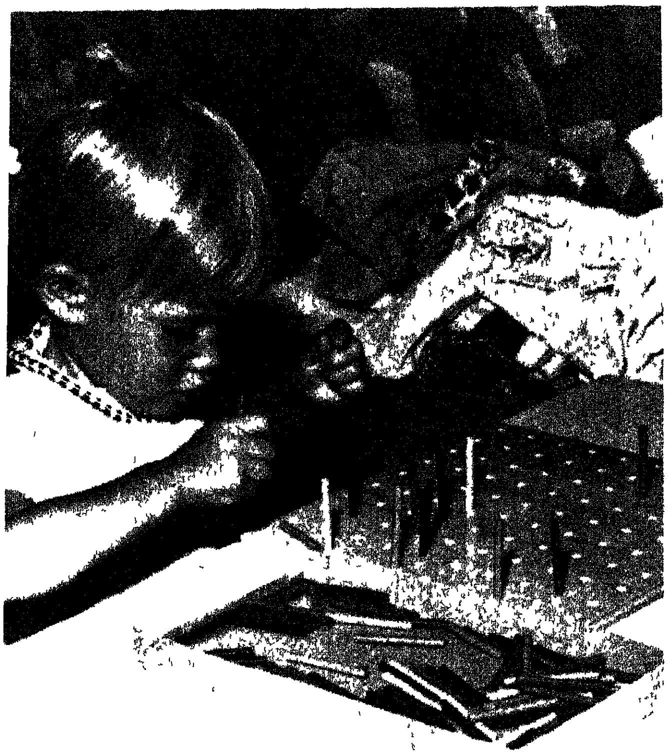
Dr. Earhart believes certain factors, at the kindergarten level, may predict reading difficulties in the first grade. Her research aims at methods that will identify reading deficiencies early, and activities to help the children overcome them.

Dr. Earhart has prepared a sequence of activities to help children learn and use different problem-solving techniques. In small, non-competitive groups, the teacher presents them with interesting materials and a variety of game lessons.

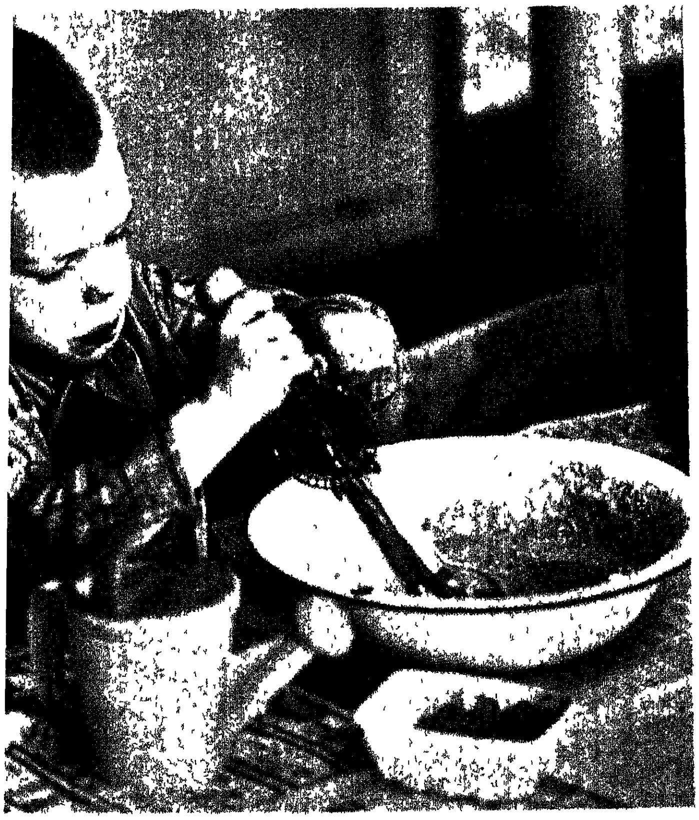
The skills emphasized in these lessons — considered basic to future learning — include (1) visual perception; (2) fine muscle coordination and tactile discrimination; (3) memory training; (4) listening and following directions; (5) classification; (6) concept building; and (7) language and vocabulary development.

Dr. Earhart's curriculum was tested in four kindergarten classes — two control groups and two which received the skill training. Tests of all four classes showed that most children in the experimental groups improved their learning skills within seven months.

It is hoped that testing will soon extend into first grade to determine the effects of the kindergarten curriculum on reading ability.



Pegboards, felt boards, blocks and simple puzzles challenge youngsters to match objects by shape, color, texture or function. Classification skills are among the most valuable throughout life. (Photo by Paul Rochlen)



Helping to prepare fingerpaints may encourage a youngster who is initially hesitant to join in the fun of smearing the paint on paper. Fingerpainting is an inexpensive activity which introduces color and color combinations, and leaves the child with something to take home. (Photo by William Mitcham)

"Parents Are Teachers, Too" (PTT) is one of the first programs to recognize just that — that parents have a primary role in the early socialization of the child.

The core of the program, developed by Dr. Boger, Dr. Judith Kuipers and other MSU researchers from the Institute of Family and Child Study, consists of parent-teacher workshops. At the workshop the teacher helps parents construct (literally) specific learning "games" they can play with their child at home.

The program's main goal is to enhance parent-child interaction. The "my mommy made this for me" sentiment can greatly enhance the positive nature of the mother-child relationship and in turn, has a powerful effect on the child's language and perceptual-motor abilities, around which the lessons were built.

Parents should be encouraged to take an active interest in the day care classes. A child gets great satisfaction from seeing friendly cooperation between his parents and his teacher. Here, one dad shows off the family pooch. (Photo by William Mitcham)

The teacher is a critical element in the success of this program. One teacher's comment to a parent involved in the program emphasizes the importance of her role:

> "I am not Johnny's only teacher . . . you are now and will always be his most important teacher. I would like to help . . . by providing you with some suggestions about what you might do when you play with him and teach him. Perhaps in the workshop sessions . . . we can build materials that will help you carry out some of your ideas."

About 160 children (100 rural and 60 urban) were chosen to test the PTT program. All of them were in Head Start classes, so over 90% were from low income families.

The program is ready for use in day care centers serving children 2½ to 5 years old.

Parent-Teacher Relations

"Should I help Jimmy put on his coat and boots, or encourage him to do it himself? Does he have the ability to dress himself? What do his parents expect of him?"

Every day care teacher — certainly one who tries to give her center a homelike, comfortable atmosphere — faces these and similiar questions with each child. She wants to foster independence — not push a child beyond his abilities or override his parents' teachings. She knows that conflict between parents and teacher — all adults he admires — may confuse and frighten a child's first school experience.

Dr. Verna Hildebrand is concerned with building a cooperative, friendly relationship between parents and teachers. She developed a questionnaire for parents to note their child's ability to do specific tasks, e.g., bathing himself, putting his toys away, answering the telephone, feeding himself, etc. They can also show whether they expect this behavior of their child.

The survey is designed to compare the opinions of several major influences on a child — his parents, his grandparents, his teacher and a student assistant.

Questionnaire results may be used to build a relevant day care program for each child. They may also provide a basis for parent-teacher meetings to explain how the center operates.

Such an effort to meet the needs of the child at home and in school should draw parents more deeply into the process of their child's education, and sensitize teachers to the needs of individual students.

[illegible]

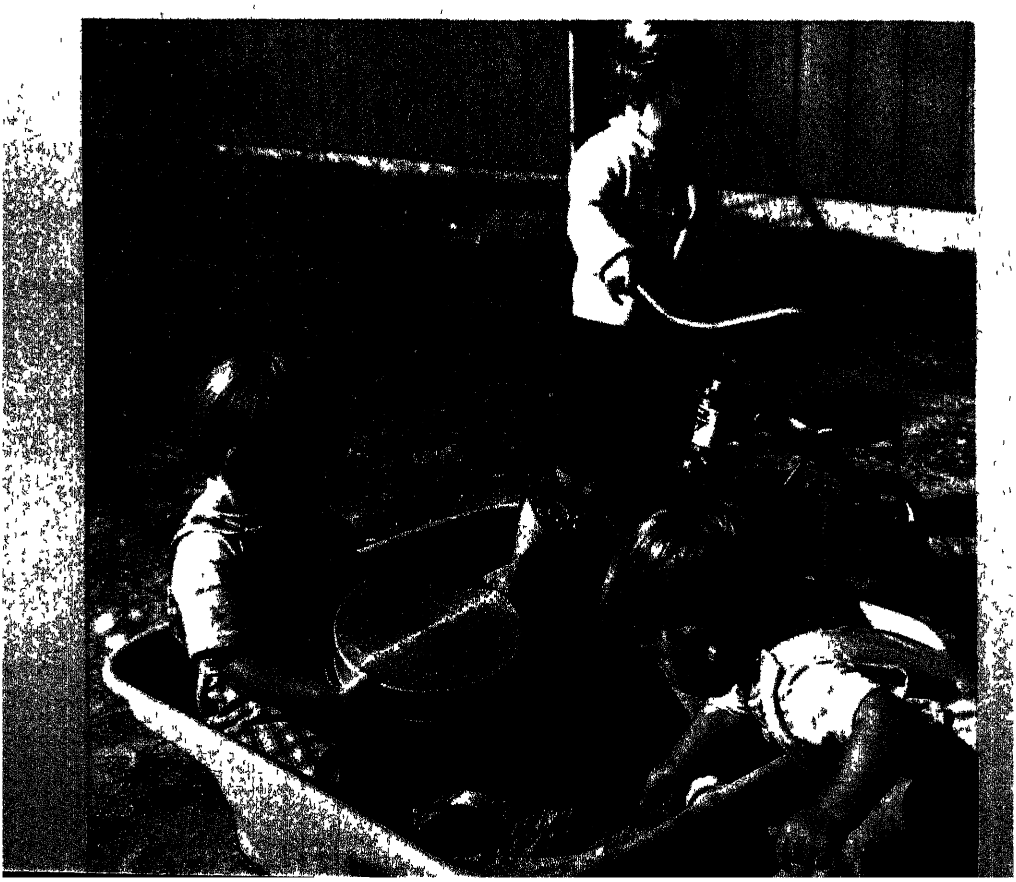
How much living space do you need? Is it enough to be able to open your dresser drawers all the way? Is ample storage and walking space all you need from your surroundings?

Dr. Gertrude Nygen and Dr. Robert Boger think the traditional housing concept — "one room per person" — may be oversimplified and outdated. Beyond sanitation, safety and convenience, how much space does each person need to develop positively in a family living situation?

What factors determine the relationship between distance, space and social behavior? No one knows exactly. But Drs. Nygen and Boger have combined housing and child development research to examine the effects of density on the socialization skills of pre-school children

"Density" has been termed one of the most important factors affecting family life. It may be the most debilitating factor arising from low-income family housing. Density, to the level of crowding, is said to produce anxiety and other reactions which result in anti-social behavior and a

Crowded home conditions may have prevented these children from freely sharing their sandbox toys. A child must be secure in the knowledge that some spaces and objects are his alone. (Photo by Paul Rochlen)



negative self-image. Thus, crowding is often associated with a high level of dissatisfaction in the home.

The study involved 80 MSU families with at least one pre-school child. Observations focused on the young family, although Dr. Nygen admits further study should include families at all stages of the family life cycle

Pre-schoolers and mothers were interviewed concerning their reactions to their home — what it looks like, what places and objects they consider "their own." Under the direction of Dr. Boger, small groups of these children (two each from relatively high- and low-density family units) were observed and videotaped during free play.

The videotapes were used to measure relative degrees of socialization. That is, do the children have the ability to initiate social behaviors, self-control, tolerance of other children, cooperation? Other tests measured curiosity toward unfamiliar tasks, task persistence and the ability to avoid distraction.

Does density really affect the way children play together? Does it make them more or less willing to share; more or less aggressive, more or less cooperative?

The study is not yet completed, but proposals for public and private housing hopefully will result — proposals that combine the best of family and personal living.

As a child grows older, he learns to appreciate occasional moments alone — away from the crowd. (Photo by William Mitcham)

School can be a treasure of new experiences. There is even an education in snack time, and tasting new foods. (Photo by William Mitcham)

Meeting the 'Hunger Challenge'

Malnutrition is a fact of life for two-thirds of the world's children — in underdeveloped countries, but also in the urban slums and rural poverty areas of our own country.

Researchers at the International Conference on Malnutrition (held at Massachusetts Institute of Technology in 1967) concluded that, besides retarding physical growth and development, nutrient deficiency can adversely affect mental growth, learning and behavior of children

To meet the challenge of hunger in Michigan better, MSU's Cooperative Extension Services initiated the Expanded Nutrition and Family Program (ENFP) in 1969. The Program goal is to improve the eating habits of low income families. Men and women, themselves from low income homes, are hired as nutrition aides and trained in basic nutrition and food buying. They share their skills with needy families on an individual or small-group basis. Each month 168 aides work with nearly 8,000 families.

Recently, MSU received a grant from the USDA to conduct a 3-year study of the Expanded Nutrition and Family Program. Dr. Portia Morris will direct the project assisted by a research team within the MSU Institute of Family and Child Study.

The research will include an evaluation of the ENFP, limited growth studies on children in the program, and the development of innovative methods of nutrition education. MSU post doctoral and graduate students, extension home economists and nutrition aides will help plan and carry out the study.

Section 37.20, P. L. & R.

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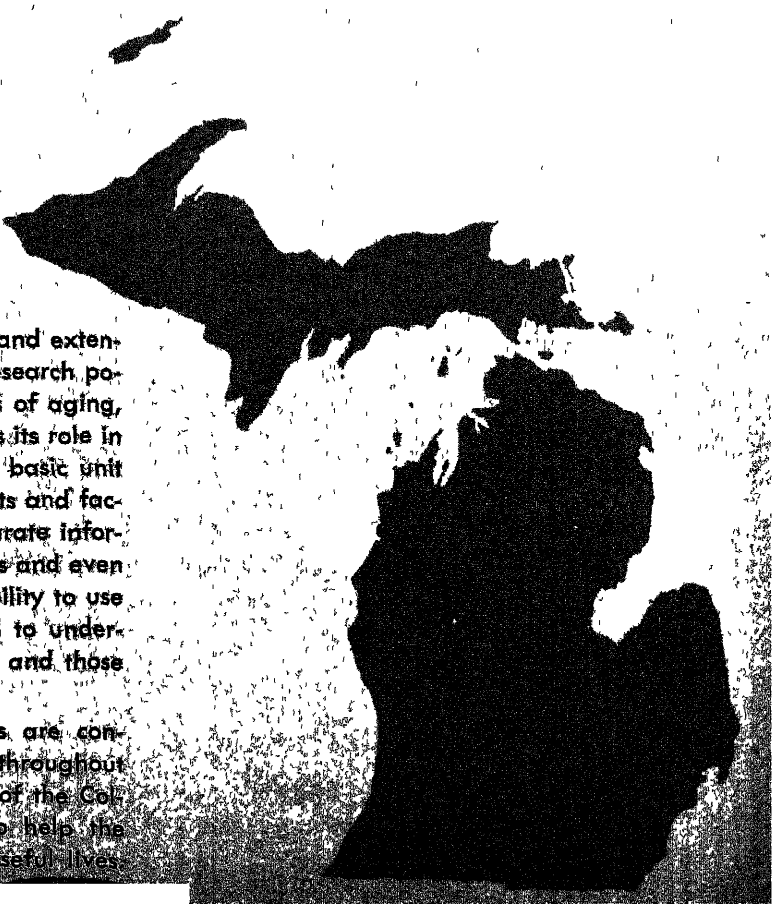
Michigan State University researchers, educators and extension personnel have only touched the surface of the research potential in child development, in the social implications of aging, and in health. With the family structure in transition as its role in society shifts, more knowledge is needed of how this basic unit operates, is changing, is influenced by other social units and factors, and in turn affects the whole of society. As accurate information and new understanding replace old wives' tales and even educated guesses, people will benefit from greater ability to use their environment, to cope with social pressures, and to understand the actions and motivations of both themselves and those around them.

MSU extension specialists and home economists are constantly alert to new research findings, carrying them throughout the state. Both the researcher and the extension arm of the College of Human Ecology feel a deep commitment to help the people of Michigan realize their goals for full and useful lives.



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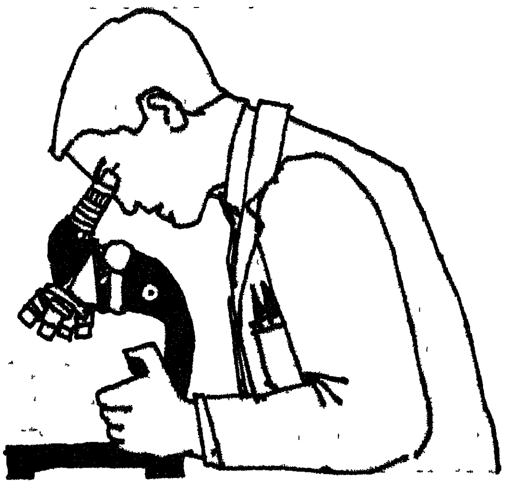

FROM THE MICHIGAN STATE UNIVERSITY
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DECEMBER 1972

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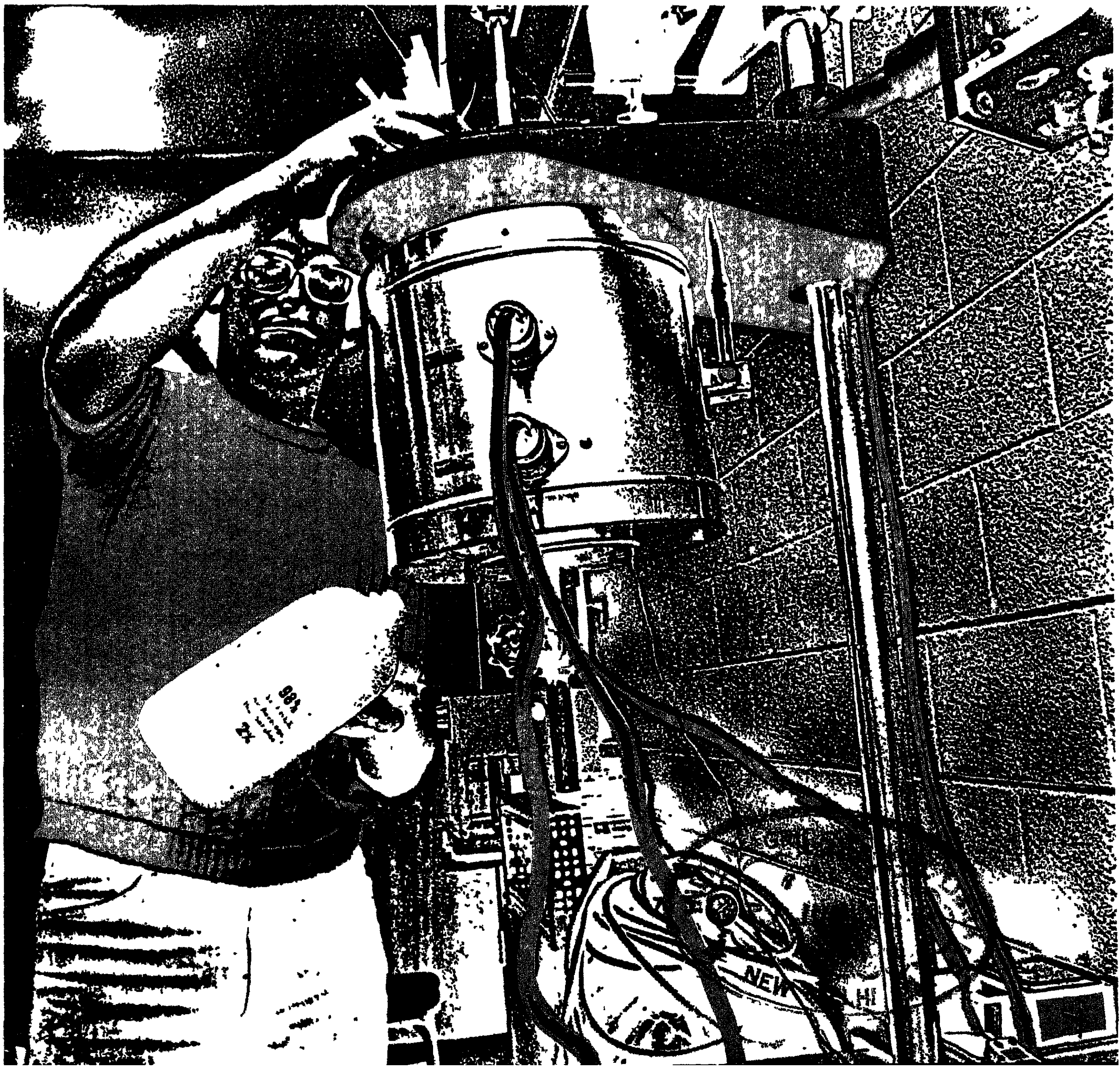
PACKAGING: for Industry and Ecology



PACKAGING:

for Industry and Ecology

For years, the 19th century country store's wooden barrels, crates and tin cans symbolized the art of packaging. Packages were containers — nothing more.

Today, packaging is a $30 billion a year industry in the U.S. And packages must meet all kinds of industrial and ecological standards.

At Michigan State University, packaging scientists work to find new, lighter weight and less polluting materials that offer more convenience and better product protection for the consumer.

The task is not an easy one. Annual shipping damages to packaged products run about $4.5 billion. "That's a frightening figure," asserts Dr. James Goff, director of MSU's School of Packaging, "especially when the volume of goods moved in the next decade is expected to double. Goods will be transported at higher speeds and in bigger loads, increasing their susceptibility to damage."

Dr Goff feels that modern industrial society cannot exist without packages, but it can certainly exist with less packaging of the kind we have now. He teaches packaging students to focus on a total packaging plan — one that meets the needs of the product manufacturer, the packaging manufacturer and the consumer.

COVER: In this recycling experiment, Charles Van Huvsen, graduate assistant in MSU's School of Packaging, grinds a polyethylene milk bottle. MSU researchers spend a great deal of time figuring ways to make packages usable instead of a glut on the environment.

TESTING PACKAGES

The MSU School of Packaging has developed a technology which can greatly reduce the need for packages, particularly secondary packages and interior protection. This technology is based on a knowledge of the distribution environment — the stresses and strains a product will face during shipment.

So each day, MSU scientists test packages. And their tests are anything but non-violent. They use high velocity shakers, skids, drops and a hundred other devices to beat the dickens out of packages. In this way, packages are subjected to the same treatment they get when dropped on a loading dock, rattled in a truck or joggled on a plane or train.

The packaging student learns to observe this "violent" environment. He notes how far a box falls in a shipment accident, how fast it falls and how often the transporting vehicle stops and starts.

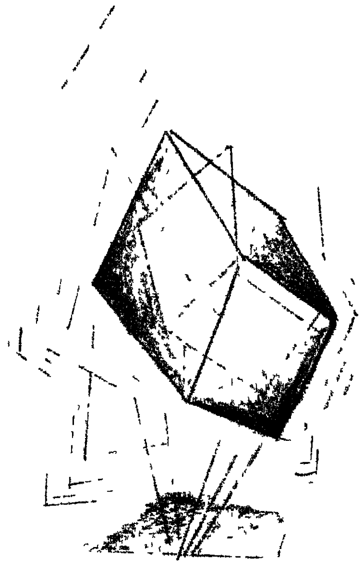
Once a packager analyzes the distribution environment, he must measure the sturdiness of the product being transported. Ideally, Dr. Goff believes, the discrepancy between what a product *can* take during shipment and what it *does* take, should be corrected in the product design, not in the package.

This approach reduces, but does not eliminate the need for protective packaging. Whatever the strength of the product inside, a package ultimately performs three functions:

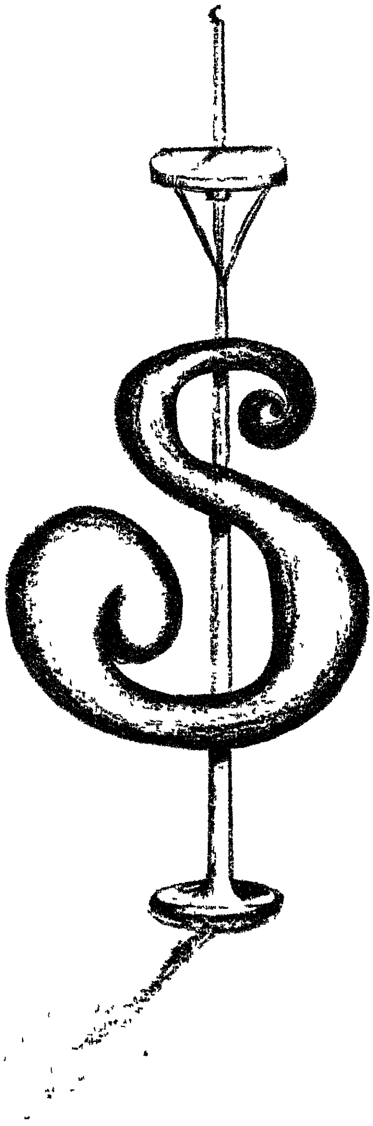
1) It protects a product from environmental hazards, and it protects people and property from hazardous products.

2) It is a convenience and an economy, saving labor and transportation costs.

3) It carries the manufacturer's assurance of quality, and directions for use.



PACKAGING PROBLEMS



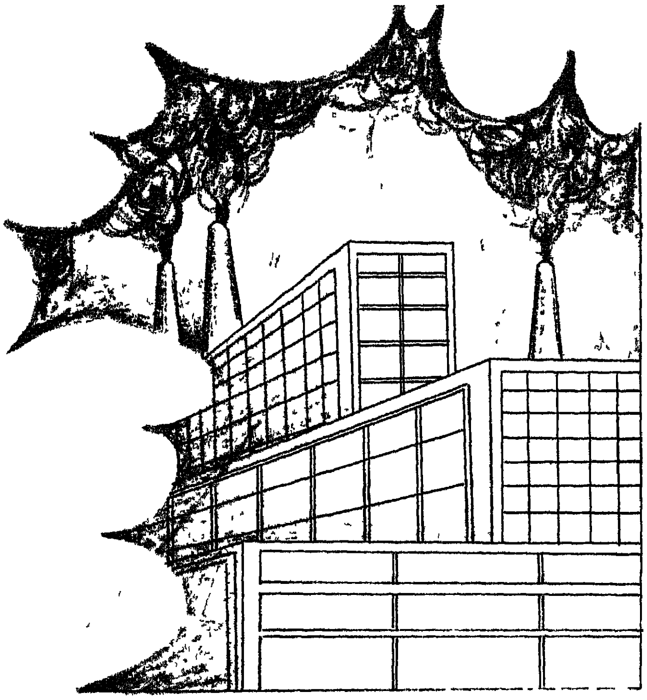
Agricultural Experiment Station scientists and other researchers in the School of Packaging walk the line between service to industry and customer satisfaction.

"But we look at packages from the consumers' point of view, contends Dr. Goff. "So if the product inside is being damaged we find out why. Sometimes we redesign the package; sometimes we modify it. But most of the time we find it easier to redesign the product than to make a new package."

Dr. Goff tells about a mail order house that wanted sales of its portable television sets to compete with imported sets. They felt that a more rugged TV would require less packaging and perhaps be more reliable than the imports. They brought prototype sets of the new model to MSU where packaging researchers put it through their "violent world." As the TV sets were banged around in the lab, it soon became evident that almost no package would protect the set as it was designed.

So MSU researchers recommended a new design. The remodeled TV is so shockproof that all it needs is a package to keep the dirt off during shipping.

Another company was losing money on its garden tractors because 70 percent of them were being extensively damaged when



trucked from the manufacturer to retail outlets. MSU researchers figured out the cause of the problem in 15 minutes! And, in less than a day they had redesigned the package to virtually eliminate hauling damage.

The crated garden tractors were put on a machine that simulated their ride in a truck. No problem occurred when the truck was cruising at highway speed. But during acceleration and deceleration, the garden tractors shook violently and damage to them was extensive.

MSU researchers bolted down the tractors so that the tires couldn't bounce. Then they put in a few blocks of wood and some other materials around the tractor so that it couldn't vibrate. Cost: negligible. Result: happy manufacturer and customers.

The success of the MSU packaging research program is due to a combination of well trained men and carefully designed testing machines.

"Our people are trained with the consumer in mind," explains Dr. Goff. "And our machines are designed to simulate actual environmental factors — shock, vibration, resonance, temperature and humidity.

"Almost anyone can build a package that will protect his product, but overpackaging can be just as costly as economic loss from product damage. We have to worry about polluting the environment with packages that can't be recycled or getting the cost of recycling so far out of line that it isn't feasible."

The shipping industry recognizes the dilemma, but it needs the help of some research institutions like MSU to cope with it.

Dr. Goff would like to see coordinated, continuing research involving diverse segments of industry. Extensive tests are needed on many different products to build a research base to help industry cope with packaging and shipping problems.

RECYCLING RESINS

In November 1971, the director of the Michigan Agricultural Experiment Station approved a research proposal for recycling used plastic packaging materials The research would be conducted jointly between the MSU School of Packaging, Department of Agricultural Engineering and Department of Agricultural Economics The project objective. "Find and develop economically viable uses for empty plastic bottles and other rigid plastic packages."

So researchers set out to find ways of re-using plastic bottles or re-molding old plastic They found the obvious way isn't always the best when recycling packaging materials.

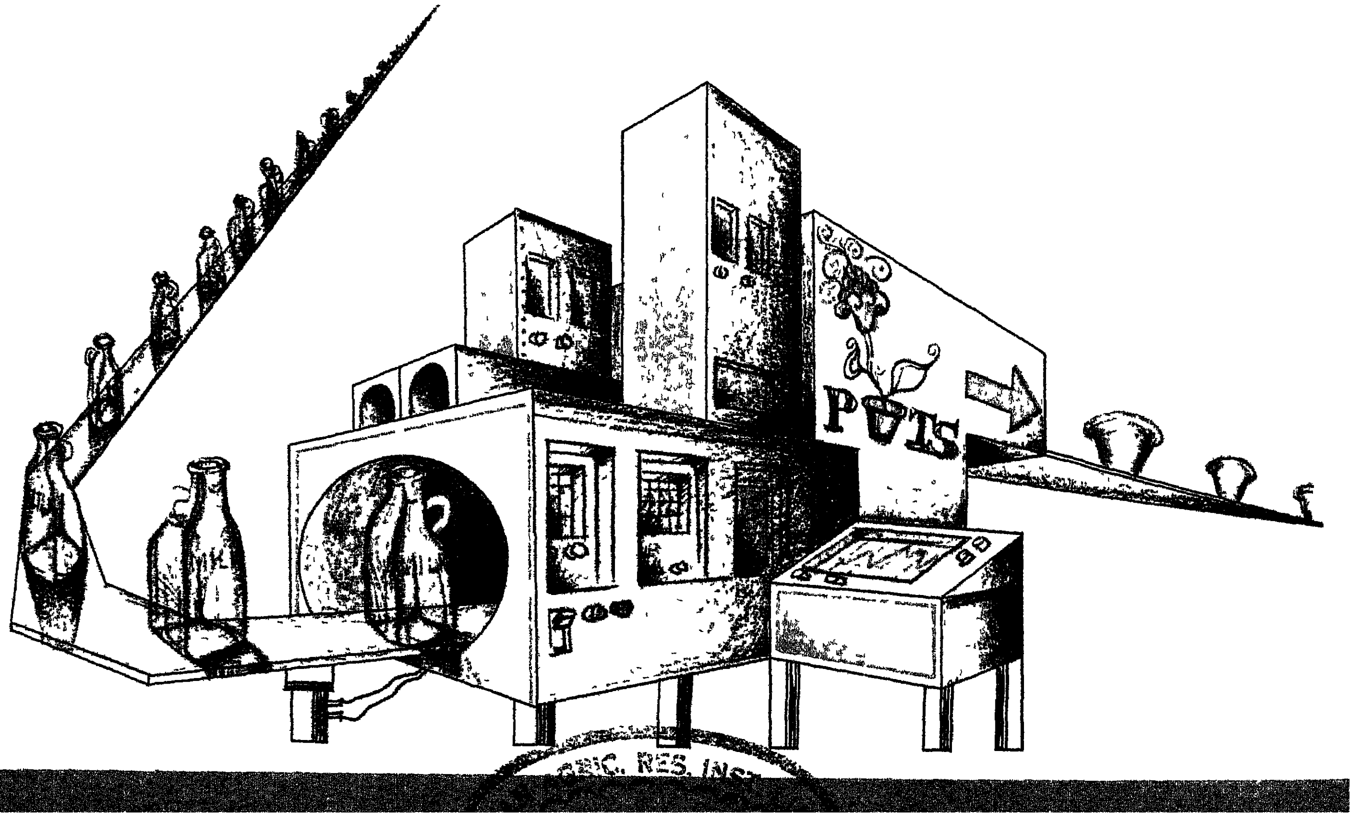
Would-be recyclers of plastic milk bottles, for example, face great competition in the low price of new plastic resins. It's often cheaper to make new containers, such as flower pots, from these resins than to collect, clean, convert to pellets and transport used containers Even if they were reused instead of recycled, the old containers would be misshapen during cleaning.

MSU researchers now believe that burning may be the most valuable, ecologically sound use for used plastic containers

"The hydrocarbon in plastics represents available fuel content," explains Dr Wayne Clifford, project leader. "Chicago has already begun to burn its refuse and reclaim the heat produced."

Another hope lies in pyrolysis In this process, plastic is heated in a hydrogen environment to give off methane, or natural gas

"These two solutions reflect the real beauty of recycling," he says "Reclaimed material can be used in the place it was generated. This saves transportation costs, and is probably the only way recycling can work



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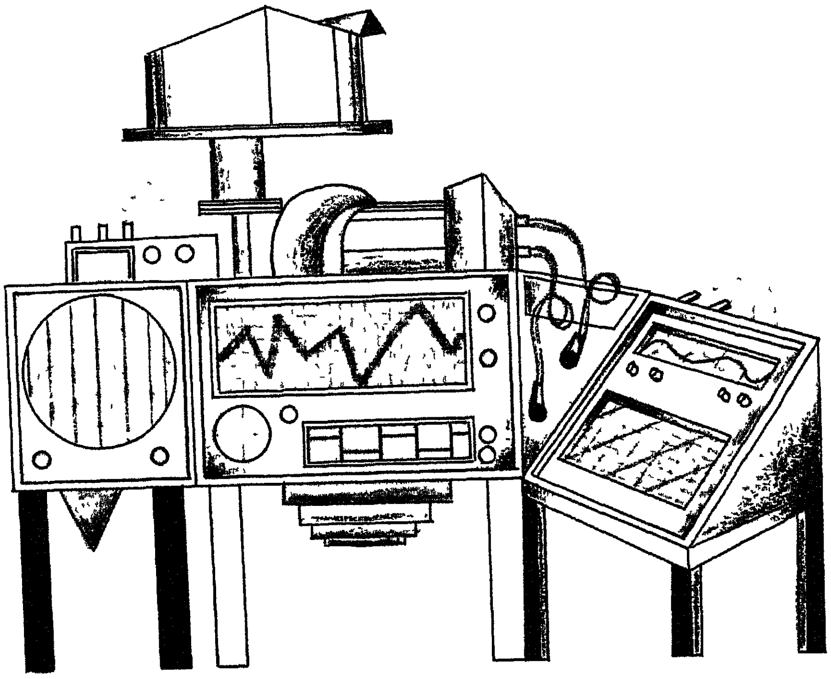

MULTI-SPONSOR RESEARCH

Since 1961, the School of Packaging has offered a unique program which allows an industrial sponsor to subscribe on an annual basis to one or more of the School's research projects. The sponsor provides a fixed fee of $5,000 per year. Two-thirds of this amount is applied to the cost of research salaries, supplies and specialized equipment, the rest is for building and equipment funds

Sponsor representatives meet on campus twice a year to advise researchers in charge of their project. The researchers, in turn, visit their sponsor's facilities and submit periodic progress reports.

Besides the solution of a specific problem, the program appeals to industries interested in promoting packaging knowledge. Sponsors also see an advantage to their future recruiting efforts, and to the training value of on-going research.

The multi-sponsor research program offers a "learning-by-doing" approach. The School of Packaging develops information for use in teaching programs, and offers a training ground for graduate students at the same time.

In addition, the sponsor fees, which amount to one-third of the School's budget, have allowed building expansion and the acquisition of about $250,000 worth of sophisticated equipment.

The equipment includes instruments which can measure precisely what shocks an object is likely to sustain, what shocks it can take and what materials or combinations of materials will cushion it best. Very few industries have these facilities.

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This is the 21st in a series of "Michigan Science in Action" publications aimed at relating the research developments in specific areas within Michigan State University's Agricultural Experiment Station.

This publication summarizes the latest research information from the College of Agriculture and Natural Resources. We've also tried to show the areas of research to which we are committed and the prospective areas in which more research will be conducted.

For further information contact Dr. James Goff, Director, School of Packaging, Michigan State University, East Lansing, Michigan 48823. Phone: (517) 353-6462.

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FROM THE MICHIGAN STATE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION, EAST LANSING
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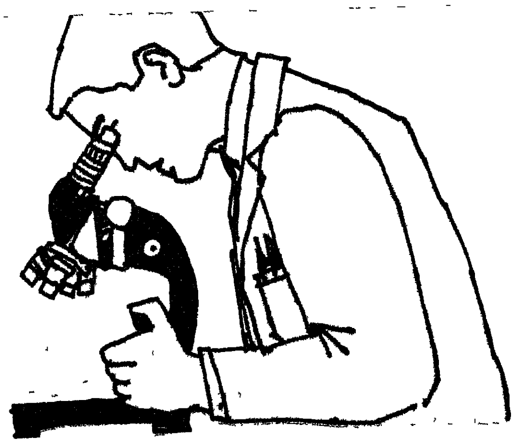

THE PLANT DOCTORS

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Plant pathology is a vital, growing science. And despite its youth, it has already conquered potato late blight (which caused the Irish potato famine) and eliminated ergot (a wheat disease that caused untold suffering in Europe during the Middle Ages) However, much information about how plant diseases affect our environment is still to be discovered.

Plant pathologists are primarily concerned with plant diseases, particularly the structural and functional changes they produce in the affected plants. Their concern provides knowledge that can be used to develop practical, safe means for controlling diseases that attack the many plants that provide food, fibre and aesthetic surroundings essential to the future welfare of our society and the world.

Our comparison of plant pathologists to specialists in human medicine is, in general, a valid one. Both groups of scientists want to discover more about the diseases that attack their patients. Besides the obvious difference in patients, one other major difference should be considered. Plant pathologists emphasize disease prevention, while scientists in human medicine focus more attention on curing diseases. The major reason for this difference is that it is much cheaper and more practical to prevent plant diseases than to cure them.

Plant diseases cost the U.S. an estimated 4 billion dollars each year – the equivalent of 25 million acres of crops that are planted but never find their way to consumers. For this reason, the "plant doctors" at Michigan State University play an important role in achieving the overall goal of the Michigan Agricultural Experiment Station; which is: maximum production of crops and livestock, maximum protection of natural resources, minimum risk of environmental pollution, and improvement of living in Michigan.

Dr. S. H. Wittwer, Director
Agricultural Experiment Station

Chemicals and control measures discussed in this publication are often experimental or in developmental stages. Their mention does not imply endorsement by Michigan State University.

DR. A. H. ELLINGBOE
Doctoring the number one field crop.

HEALTHY PLANTS

MSU plant doctor A. H. Ellingboe is working to provide healthier corn plants for Michigan farmers. To do this, he helps MSU corn breeders develop new, disease resistant corn varieties and studies how resistant plants react when a disease organism is present.

Yellow leaf blight (YLB) – a fungus disease of corn – was first found in Michigan in 1964. However, YLB did not become a problem until 1968 when it infected commercial corn fields on a widespread basis.

In 1969 Ellingboe began a search for corn varieties resistant to the disease. About 500 varieties were screened and, of these, one line showed high levels of resistance to YLB. The resistant characteristic has now been bred into five commercial varieties providing disease protection for Michigan farmers.

But the search for other corn varieties that show resistance to YLB has not stopped. By combining several lines with low resistance, MSU plant doctors may be able to boost the resistance levels of some corn varieties. According to Ellingboe, the YLB research program has four major objectives:

1) To find more sources of resistance to YLB and genetically incorporate them into commercial corn varieties. A wide range of resistance to the disease is needed to prevent possible mutations in the fungus that could overcome the resistance in an entire corn crop.

2) To determine how easily resistance can be incorporated into commercially accepted corn varieties and if there is genetic evidence that resistance differs from source to source.

3) To determine if different sources of YLB resistance affect how the fungus invades, or fails to successfully invade, the corn plant.

4) To find out if corn varieties with low levels of resistance could be helpful in controlling YLB epidemic buildup in the field.

Eye spot, another fungus disease of corn, showed up in Michigan in 1970. Now Ellingboe and his colleagues are beginning the same sort of research program that is being followed on YLB problems. "We are now looking for corn lines that are resistant to eye spot and have potential for use in breeding varieties that won't be affected by the disease," he says.

THE SEARCH IS ON

After the outbreak of southern corn leaf blight (SCLB) in 1970, hybrid corn producers began a rapid shift to hybrids developed from parent corn lines with normal germ plasm in their reproductive cells because these plants showed resistance to the fungus disease.

Not all hybrids developed this way have the same degree of resistance to SCLB, however, so MSU plant doctors are searching for corn varieties and lines that show the most resistance.

Once several good lines with high levels of resistance are available scientists will attempt to breed this resistance into commercial hybrids less tolerant to SCLB.

Ellingboe and his colleagues hope to establish a wide base of resistance in commercial hybrids reducing the possibility of future SCLB epidemics.

TOXIC COMPOUNDS

"Identifying the chemical compound(s), responsible for plant disease isn't easy," says MSU plant pathologist Dr. Robert P. Scheffer. Most disease causing organisms (pathogens) release or create many compounds, most of which are not involved in the initial infection process.

After the toxic compound is identified and isolated, plant scientists must find out how the substance acts on the cells of the host plant and why some crop varieties are resistant to the disease and others are not. An understanding of the chemical basis of plant disease infection may be useful in quickly solving or avoiding future disease problems.

Scheffer's efforts are directed primarily toward fungus diseases of oats, corn and sorghum. After detailed studies of Victoria blight, a fungus disease of oats, Scheffer and his colleagues developed the following hypothesis:

> *When the fungus spore germinates in a host plant, it releases a toxic chemical called a peptide or "little protein." This toxin reacts with a protein contained in the cell membrane, changing the chemical construction of the cell and interfering with vital processes. Vital materials leak out of the infected cell and the fungus uses these for its own growth.*
>
> *In resistant varieties, the cell membrane doesn't contain the key protein, so the toxin, even though it is present, can't break down the cell membrane.*

Since his work on Victoria blight of oats, Scheffer and other scientists have described nine similar cases including diseases attacking sorghum, corn, sugar cane, citrus trees and apple trees.

DR. ROBERT P. SCHEFFER
New theories of infection.

This research has led to the solution of disease problems of oats and sorghum through the understanding of genetic resistance. The toxins are now being used by plant breeders in programs aimed at developing new resistant oat and sorghum varieties. In some corn diseases, particularly Southern Corn Leaf Blight, the situation appears slightly different.

The mitochondria — tiny power houses of the cell where food is changed to energy for growth — appear to be very sensitive to the disease toxins. "If the mitochondria are knocked out, the cell dies," says Scheffer. "More work needs to be done before we are sure that this is really the process involved."

Present Disease Problems

Soybean production is rapidly increasing in Michigan as farmers look for cash crops that can provide better profits. But according to MSU plant pathologist Dr. John L. Lockwood, very little soybean disease research has been conducted in Michigan.

DR. JOHN L. LOCKWOOD
Soybeans and soil fungi.

Already a new type of soybean root rot causing damage in many parts of the state has been identified. Studies of the whole soybean root rot complex are underway in an effort to discover which fungus causes which disease, how important each disease is, and how major diseases can be controlled.

In southwestern Michigan some farmers plant soybeans only to discover that the plants will not grow in certain parts of the field. "The problem is due to seedling decay, but we don't know what causes it yet," says Lockwood.

Soybean pod and stem blight investigations are farther along, however. This disease is caused by a fungus carried in the seeds. It can reduce seed germination but does not occur every year. Field tests of seed treatment chemicals did not yield sufficiently impressive results to make any recommendations. Lockwood also hopes to study the impact of pod and stem blight on the state-wide production of soybeans.

Pesticides and Soil Life

Lockwood has also studied how agricultural chemicals react with the tiny life forms that live in soils. He was one of the first scientists to show that soil microorganisms break down DDT, but that this breakdown process does not result in a completely harmless chemical residue.

He has also conducted similar studies with another widely used chlorinated pesticide called pentachloronitrobenzene (PCNB). These studies showed that soil microorganisms take up and concentrate chlorinated pesticides. Then soil animals – such as nematodes, collembola, and possibly earthworms – that eat soil microorganisms concentrate these long-lived pesticides still further. Thus food chain concentration of these pesticides exists in the soil, as well as in water and above-ground ecosystems.

In another study, Lockwood found that even low levels of Atrazine (a herbicide generally used to control weeds in corn), can drastically change the population of soil microorganisms.

Soil Fungi

Lockwood is probably best known for his research on soil fungi. His research dealing with enzymes, cell walls and molecules, enables scientists to learn more about the life cycles of these microorganisms. "The more we know about disease organism life cycles, the easier it will be to control them economically and without hazard to the environment," says Lockwood.

One of his research efforts is a long-term investigation of how fungi survive in the soil. He seeks answers to questions like 'What keeps the spores from germinating before they encounter a host plant?' Research indicates the spores do not germinate because the soil lacks essential nutrients for fungus growth. This is contrary to another scientific view that certain inhibiting substances in the soil prevent germination. To find out why most growing fungi are destroyed in soil unless food is present, Lockwood has developed a laboratory technique that imitates nutrient stresses that occur in soils.

Some people think that other soil organisms attack and dissolve the fungus, but research at MSU shows that enzymes capable of destroying the growing stage of the fungus increase as starvation stress increases. "As destruction of the growing stage of the fungus begins, certain chemical compounds are freed and thus become available for use in the formation of resting structures," says Lockwood. "These resting structures may be spores or more complex structures; they are resistant to destruction and allow the organism to survive periods of stress."

DR. A. W. SAETTLER
Protecting an entire industry.

BEAN BLIGHT

In the U.S., Michigan is King when it comes to the production of dry edible beans, particularly Navy beans. Because of this, plant doctors at MSU take a serious interest in dry bean diseases.

According to Dr. A. W. Saettler, U.S. Department of Agriculture plant pathologist stationed at MSU, bacterial diseases are the most serious threat to the state's bean industry because they are transmitted by seed.

"This is further complicated by the fact that Navy bean production is almost entirely limited to a seven county area in the Saginaw Valley and Thumb regions of the state," says Saettler, "where environmental conditions encourage growth of these diseases.

In Michigan there are three major bacterial diseases of beans: common blight, fuscous blight and halo blight. These diseases are seed transmitted and spread from plant to plant by mechanical injury, rain, hail or wind. All can survive in plant refuse in the soil for at least one year.

When infections occur in the pods, the developing seeds are attacked by the bacteria. If these infected seeds are planted, the bacterial blight will almost certainly be transmitted to the new crop. All Michigan bean varieties are subject to attacks by common and fuscous blight, but halo blight only attacks colored bean varieties such as red kidneys, cranberry and yellow eyes.

In 1967 Saettler and other MSU plant doctors reported that halo blight could be controlled with chemical sprays. Since that time the recommendations for controlling this disease have been perfected and are now being used by commercial bean producers throughout the state. However, chemical sprays do not effectively control common and fuscous blight problems in the field and there is no seed treatment that will selectively kill bacteria under the seedcoat.

Seed Testing

To beat blight bacteria, Saettler and his colleagues developed a testing program aimed at providing Michigan bean growers with blight-free seed for planting.

Growers producing Navy beans for seed were asked to send five pound samples to the MSU Plant Diagnostic Laboratory for testing. There technicians sterilized some of the seed so that surface bacteria would not affect test results. Then the seeds were soaked in water overnight. The resulting liquid was cultured in an artificial medium suitable for bacterial growth, or injected into 10-day-old bean seedlings. Remaining unsterilized seeds from the five pound lots were used to detect blight bacteria on the surface of the seeds.

Saettler and his team of investigators did not stop here. "Knowing which seedlots don't have internal blight infection isn't enough," he says, "since almost 80% of the seed produced in the state shows blight organisms on the surface of the seed." The scientists solved this problem by treating seed free from internal blight contamination with a water solution containing a bactericide, fungicide and insecticide.

Though the program has only been operating for 3 years, it seems to have helped. In the first year, 1970, 58% of the seed tested showed evidence of blight infection. In 1972 only 27% of the seedlots tested showed blight infection. For its first 2 years of operation the bean seed testing program was conducted by MSU plant doctors. Now, however, the program has been improved and is conducted by plant pathologists from the Michigan Department of Agriculture.

SEED TESTING
Blight free seed won't produce diseased plants.

Blight Studies

Saettler is also studying blight bacteria survival in the soil. "We're looking at questions like, 'Do the bacteria overwinter,' and 'if so, what crop rotations should a grower use to avoid planting beans in bacteria infested soil?' "

In other studies Saettler is attempting to find out if there is any difference between the bacteria that cause common blight and fuscous blight. The only known difference between the two organisms is that they produce different colors when artificially grown in the laboratory.

CONTROLLING POWDERY MILDEW

Because they threaten one of Michigan's major cash crops, wheat diseases get a lot of attention from MSU plant doctors

Powdery mildew – a fungus that attacks wheat and other cereal grains – is of particular interest to plant pathologist Dr A H Ellingboe. To help provide more immediate relief from the threat of powdery mildew, Ellingboe and MSU wheat breeders are continually looking for new wheat varieties resistant to the disease. Promising resistant types are saved for possible use in the university's wheat breeding program

Ellingboe is also studying the relationship between the parasitic fungus and the host wheat plants. His research includes a study of the host/parasite interaction during the early stages of infection. From this research Ellingboe hopes to find what host/parasite interactions occur, how many of them are critical to infection or non-infection, and what genes are involved.

Such information should provide a genetic "map" for resistance to powdery mildew and aid in developing future disease resistant small grain varieties.

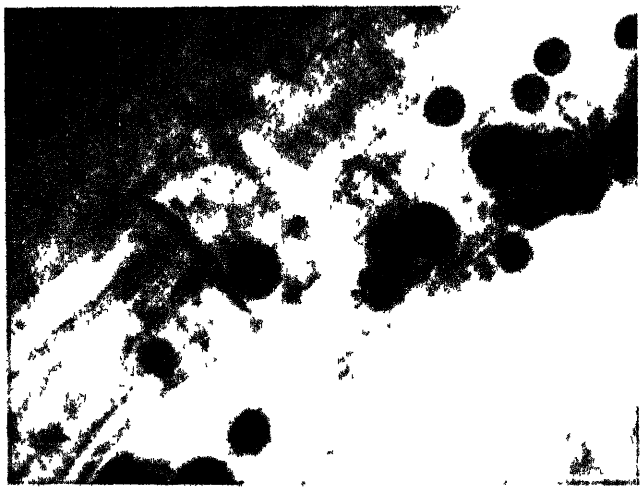
STRUGGLING WITH LEAF STRIPE

Cephalosporium leaf stripe, a soil-borne fungus disease of wheat, is widely distributed throughout the wheat growing areas of Michigan It is estimated that the disease can reduce state wheat yields by as much as 5% each year.

Due to the widespread nature of the fungus disease, MSU plant doctors are concerned about potentially greater yield losses. "On one farm 5% may not seem like much, but when you consider the more than 20 million bushels of wheat produced in Michigan each year, a 5% loss is considerable," says Dr. M. V. Wiese, MSU wheat pathologist.

During 1970-71, leaf stripe was partially controlled in East Lansing test fields by delaying planting of winter wheat one week beyond the normal fall planting date. "We also tried chemical seed treatments," says Wiese. "Some were partially successful; delaying but not eliminating the disease."

DR. M. V. WIESE
Struggling with leaf stripe – and other wheat diseases.



FUNGUS SPORES IN WHEAT ROOTS
Do they carry the virus?

Life Studies

Knowing exactly how the *Cephalosporium* fungus lives and reproduces should provide clues for controlling the disease.

For example, a new technique was recently developed for determining if the fungus is present in a field, and how plentiful it is.

The technique will permit plant doctors to find out how plentiful the fungus must be in the soil before wheat yields are significantly affected, and how the fungus population is affected by climate and cultural practices. Farmers could then plan crop rotations designed to prevent disease outbreaks.

What does *Cephalosporium* do once it gets inside a healthy wheat plant? According to Wiese, the fungus enters the roots and invades the xylem vessels of the wheat plant (the tubes that conduct water throughout the plant), where it gives off by-products that prevent movement of water, nutrients and waste products into and out of the xylem tube.

Unable to exchange these materials, the cells around the infected xylem tubes become yellow and die causing the typical leaf stripe symptoms. The growing fungus eventually packs the xylem tube, cutting off water flow almost completely, and thereby seriously damaging the ability of the wheat plant to grow and form seeds.

DISEASE OUTBREAK FOILED

The new variegation disease caused by wheat spindle streak mosaic virus was prominent throughout the state in the spring of 1971. This outbreak was a blessing in disguise, because it allowed MSU plant doctors to select several wheat lines that show resistance to the disease.

"Nearly 200 different wheat lines were evaluated for resistance to the virus disease," according to Dr. M. V. Wiese, MSU plant pathologist. The most promising varieties were Blueboy and a selection from a Russian feed wheat. The Russian wheat showed no disease symptoms during testing. These varieties are now being used to develop new wheat varieties resistant to spindle streak mosaic virus and adapted to Michigan growing conditions.

Wheat Virus — Its Private Life

Using an electron microscope, Wiese studied the development of spindle streak mosaic virus in wheat. Before visible symptoms of the disease appear, host cells are filled with abnormal membranes, rod-like structures, and surfaces where pinwheel-shaped inclusions are formed. The rods and pinwheels appear at the time leaf symptoms are produced.

"We were able to isolate virus-like particles from infected plants," says Wiese, "but preparations weren't completely pure and didn't cause the disease when placed in healthy plants. We may have damaged or killed the virus particles while isolating them, so we are modifying the purification procedure to allow us, hopefully, to isolate an intact and infectious virus."

FUNGUS + VIRUS = TROUBLE

Recently, Wiese discovered a soil-borne fungus that may be infected with the wheat spindle streak mosaic virus, and may transmit the virus to wheat. Numerous spores of this fungus are found in the roots of virus infected plants

POOR NUTRITION HURTS

Those darker colored, blotchy potatoes have scab. It won't hurt to eat them, but it hurt the farmer's pocketbook.

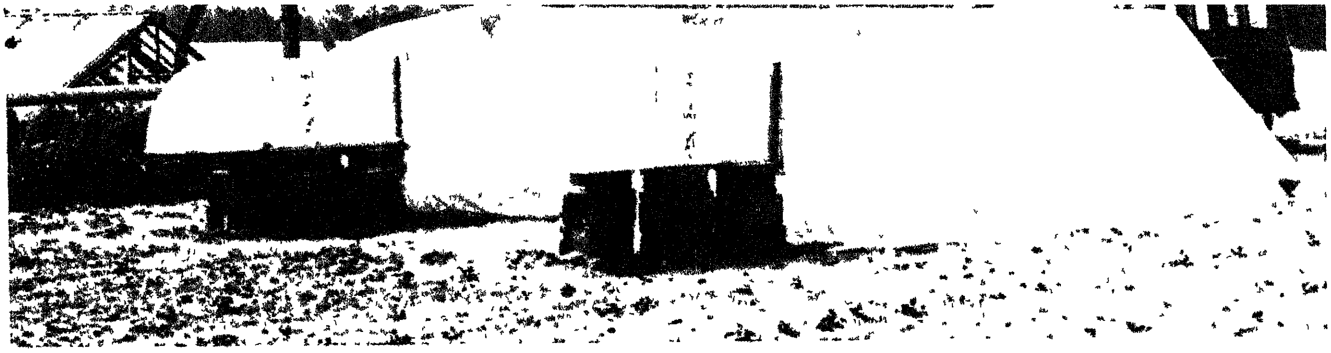
Potato scab, a fungus disease carried in the soil, causes serious economic losses to potato producers in Michigan and other potato producing areas of the United States.

According to Dr Howard S. Potter, MSU plant pathologist, losses from scab are due to reduced market quality caused by scab-like disfigurement of potatoes In severe cases, yield reductions may also result.

Potter has been studying potato scab since the 1950's Over the years his studies have resulted in new cultural techniques and soil fungicide treatment recommendations that have allowed the industry to grow potatoes on severely infested soils and to use varieties that are susceptible to the disease.

The fact that scab severity is related to nitrogen in the soil is the basis of Potter's latest experiments on potato scab problems. For this work Potter chose a farm near Greenville, Michigan, where scab had been such a severe problem that potatoes had not been grown there for 20 years. The key treatment being analyzed was a nitrogen stabilizer — a compound that keeps ammonium fertilizers from breaking down rapidly into nitrates Although total yields were not influenced by the treatment, it produced a startling increase in the percentage of top quality potatoes.

As a result of these experiments, Potter recommends a fall cover crop on land to be planted to potatoes, so that a low nitrate level occurs in the spring. "A fall cover crop along with a nitrogen stabilizer provides a practical means of controlling potato scab," he says.



PORTABLE GREENHOUSES FOR STUDYING PLANT GROWTH IN POLLUTED FIELD AIR

AIR POLLUTION CHOKES CROPS

Air pollution damage to plants is increasing across the country, says Dr. William J. Hooker, Michigan State University plant pathologist. Surveys indicate that air pollution damage to crops, forests and ornamental plants costs the U.S. more than $500 million each year This problem has not escaped Michigan, so MSU plant doctors are working toward possible solutions.

Potatoes are especially subject to air pollution damage, being the first major Michigan field crop to suffer serious, widespread, commercial yield losses In severe cases, air pollution damage causes premature death of potato vines and a reduction in yields and tuber size. When a susceptible variety is grown where air pollution levels are high, yields may drop by 50% or more.

MSU plant pathologists have studied air pollution and its effect on plants since 1967. Only recently, however, did they discover that potato speckle leaf was caused by polluted air.

Hooker and his colleagues put the finger on air pollution by building portable, plastic greenhouses in fields where potato speckle leaf was severe The air in one house was filtered while the other received unfiltered air. In the house receiving filtered air, indicator plants (plants sensitive to air pollutants) such as potato, tobacco, bean and white pine, were normal and healthy. In the house with non-filtered air, growth was abnormal and the plant leaves were often severely spotted.

According to Hooker, air pollutants that pose the greatest threat to plants include photochemical oxidants. These pollutants are formed by reactions be-

POLLUTION INJURED THE POTATO PLANT ON THE LEFT

tween sunlight and chemical pollutants released into the atmosphere. The new gaseous chemicals formed can be highly toxic to man, plants and animals

"The major source of photochemical oxidants is car and truck exhausts," said Hooker "The two major photochemical pollutants involved are ozone (0_3) and peroxyacetyl nitrate (PAN) We are relatively confident that the potato speckle leaf disorder is caused by ozone and/or PAN."

Scientists are now looking for possible ways to prevent or reduce the damage caused by air pollution During their initial tests the systemic fungicide Benlate gave excellent protection from air pollution injury on tobacco and bean plants However, in preliminary field trials, potatoes did not respond to Benlate treatment (only the susceptible variety Norchip was tested) Hooker and his colleagues plan to conduct further studies next year.

Hooker cited two major reasons for the air pollution studies

1) Air pollution injury to crops could easily be mistaken for disease damage, resulting in the wrong treatment.

2) Further studies of Benlate are needed to determine the difference between its action against fungus-caused disease and its action against air pollution damage

DR. W. J. HOOKER
He developed this microtome to study fresh plant tissue

LIGHTNING ZAPS MICHIGAN POTATOES

Michigan potatoes have been getting zapped by lightning for years, but now there's a new twist.

Dr William J Hooker, Michigan State University plant pathologist, noticed for the first time this year more lightning injury to crops in fields with solid set irrigation systems. Aerial photographs of several potato fields showed that the portions of fields that got more irrigation water seemed to be more susceptible to injury.

In one field, circular patterns of injury corresponded closely with spray patterns from certain nozzles along the pipe The type of lightning damage well known to Michigan potato growers is a circular or oval shaped area of dead vines in the field. But when solid set irrigation systems were in the field, the injured plants were in scattered areas often widely separated In severely hit areas, potato plants wilted and died almost immediately. In areas of lesser injury, plants survived for as long as 20 days.

Lightning plays odd tricks and predictions of its action are seldom successful More cases of lightning injury must be studied before scientists can make recommendations that might ease or resolve the problem.

ZAPPED POTATOES
The pattern is due to soil moisture levels

DR. C. L. SCHNEIDER
Putting a little sweetness into life.

TRY A LITTLE SWEETNESS

Dr. Charles L. Schneider, a USDA plant pathologist stationed at MSU, tries to "put a little sweetness" into the lives of midwestern folks. He acts as part of the USDA scientific team, including plant breeders, agronomists and plant physiologists, whose goal is to improve sugar beet varieties and solve sugar beet problems in the north central production area that includes Michigan and Ohio.

According to Schneider, three major diseases attack sugar beets in Michigan and Ohio – leaf spot, black root, and Rhizoctonia crown and root rot. All are caused by microscopic fungi in the soil.

The USDA sugar beet research effort has benefitted greatly from cooperation and support provided by state experiment stations and beet sugar manufacturing companies.

A Three-Pronged Attack

Schneider uses a three-pronged attack on each major disease problem faced by sugar beet growers in Michigan and Ohio:

1) Development of disease resistant varieties.

2) Development and evaluation of better and safer chemical control measures.

3) Development of cultural practices that reduce the impact of diseases.

In each case, studying the disease causing organism is the first step in the search for a solution to the problem. By studying the life-cycle of these organisms (pathogens) we can often find a weak link in their life processes that offers a better means of controlling the diseases.

Resistant Varieties

Developing disease resistant sugar beet varieties through plant breeding is an effective way to control beet diseases. Breeding and testing a disease resistant variety is a long process, however, so Schneider has developed a technique to speed it up.

By creating tiny, mini-environments in the greenhouse he can evaluate many more sugar beet lines for resistance to black root, save time, space and labor, plus obtain better accuracy. By controlling the amount of disease organisms present, scientists can distinguish between resistant and susceptible types – an event that does not occur in nature every year – and then select plants that do best for use in further breeding programs.

Greenhouse studies also provide the advantage of working with known types of the disease causing fungi. Because so many fungi are present in a sugar beet field more than one pathogen may be involved during a field trial. However, new sugar beet lines are subjected to rigorous field trials to insure that they are resistant to all diseases that may occur in the area.

Schneider has already found several promising sugar beet lines among those produced by the USDA sugar beet laboratory in Colorado. These include sugar beet lines resistant to Michigan and Ohio isolates of the Rhizoctonia root rot fungus.

Safer Chemicals

To find fungicides that provide better disease control without hazard to the environment, Schneider conducts cooperative research studies with other MSU plant pathologists. In some of these studies scientists examine new chemicals and compare their effectiveness and safety with compounds commonly used to control sugar beet diseases.

Other studies are aimed at improving control and reducing the chances of environmental pollution. Schneider and his colleagues test lower than normal rates and fewer than normal sprays of fungicides to see if a smaller amount of a chemical can do the job. Improved spray equipment and spray additives that show potential for reducing spray drift problems and for increasing the effectiveness of fungicides are also investigated.

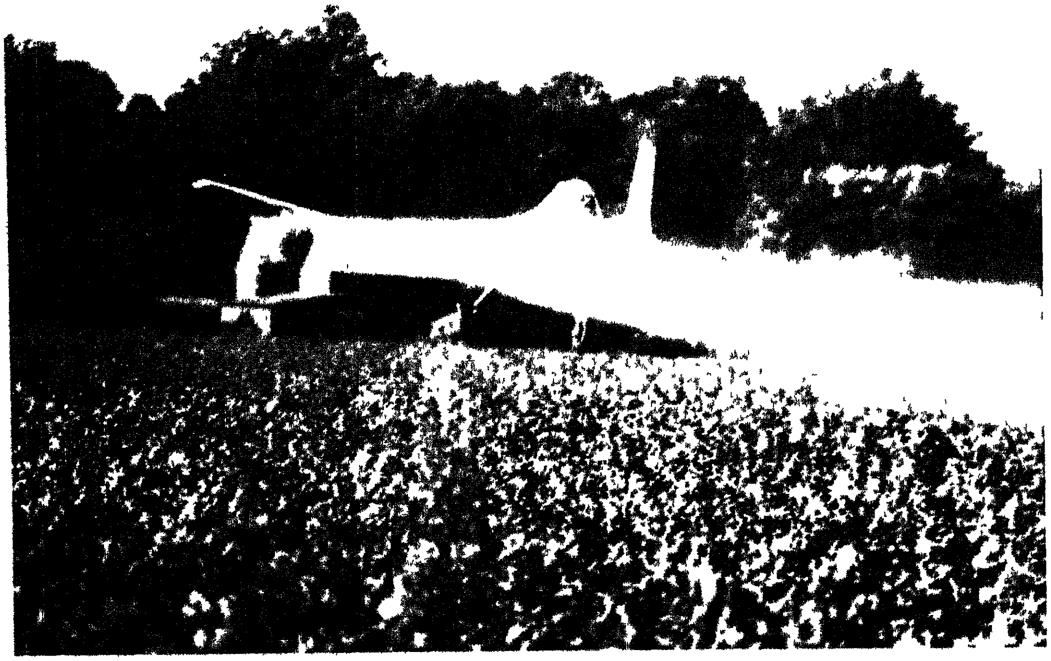
Foam additives give excellent results in both air and ground applications. Almost all of the chemical reaches the target plants, reducing waste and environmental risk.

Information gained from these studies is used to update the chemical use recommendations published annually by the Michigan Agricultural Experiment Station.

Cultural Practices

In his third organized attempt to thwart sugar beet diseases, Schneider takes a close look at the farming practices commonly used by sugar beet growers in Michigan and Ohio. For example, recommended control measures for the three major sugar beet diseases include crop rotation – several cash crops are selected and a different one is grown in the field each year. Crop rotation helps keep disease organisms from building up in the soil.

Other cultural studies related to disease control include examination of how cultivation practices, fertilizer rates, soil acidity and the handling of crop residues affect the incidence of disease.



SPRAYING BEETS
Looking for better disease controls.

UP, UP IN THE AIR

MSU plant doctors took to the air – about as high as a crop dusting plane flies – to solve down-to-earth problems.

One problem is *Cercospora beticola*, better known as leaf spot – a fungus disease that reduces sugar beet yields and profits for growers.

In 1970 and 1971, MSU plant pathologists tested the effectiveness of two systemic and three surface protecting fungicides applied by airplanes. The experiments took place on sugar beet farms near Ida, Michigan, and Ottawa and Green Springs, Ohio.

According to MSU plant pathologist Dr. Howard S. Potter, three other major variables were studied during the tests:

1) Five different types of fixed-wing airplanes were used.

2) Conventional spray booms were compared to Micronair rotary atomizers.

3) Two different intervals between sprays were used. In 1970, the fields were sprayed five times at 14-day intervals. In 1971, two applications were made 21 days apart.

Leaf Spot Takes a Nose Dive

All spray treatments effectively reduced the intensity of leaf spot symptoms but the systemic fungicides (benomyl and thiabendazole) gave the best control. The research proved that the disease could be controlled with only two applications of fungicide. At one location good control of leaf spot was obtained with only one dose of systemic fungicide.

Yields Take Off

"By reducing leaf spot infection levels, sugar beet yields were boosted by as much as 4.5 tons per acre over the untreated control plots," notes Potter. Yields of sugar per acre soared accordingly – sometimes up to 30% more.

MORE MICHIGAN MINT

Before 1940 many people in the world tasted a little bit of Michigan every day — when they brushed their teeth with paste or powder, ate a piece of candy, took medicine or chewed gum. All these products use mint oil for flavoring, and before 1940 Michigan was the world's major producer of high quality peppermint oil.

Then came Verticillium wilt — a fungus disease that practically wiped out mint production in Michigan and forced mint oil buyers to look to the U.S. Northwest, where the disease is not as great a problem, for oil supplies. However, atomic energy and 16 years of research conducted by scientists at public and private institutions have given the mint industry in Michigan and the U.S. a "new lease on life." The important breakthrough is a new peppermint variety resistant to Verticillium wilt.

Atomic energy got into the picture when Dr. M. J. Murray of the A. M. Todd Company, Kalamazoo, (a supplier of mint oils) began exposing mint plants to radiation at the Brookhaven National Laboratory in 1955. Fifteen years later Murray came up with a wilt resistant mutation known as Todd's Mitcham.

Dr. M. L. Lacy, MSU plant pathologist, assisted in the process by conducting field tests of Todd's Mitcham and other promising varieties developed by Murray. Other field tests were conducted by Agricultural Experiment Station scientists in Indiana, Oregon, Washington and Idaho. According to Lacy, another research development is now available to help mint growers beat the Verticillium wilt problem.

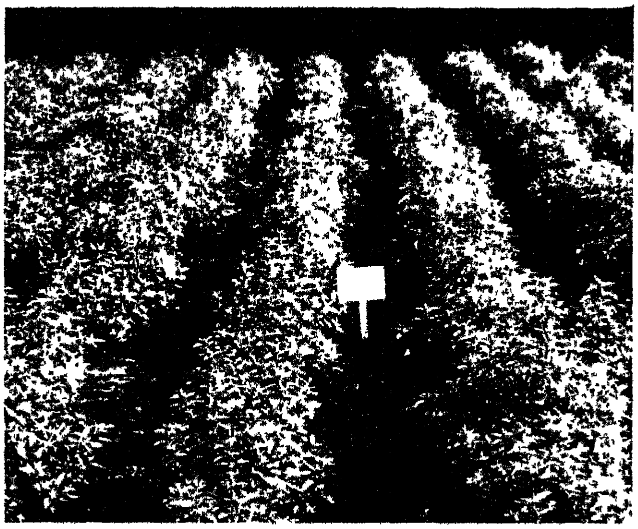
Because cultivating mint fields speeds the spread of Verticillium wilt and since weeds can discolor the mint oil and may add undesirable odors, herbicides seemed the obvious answer to both problems. The first MSU studies of chemical weed controls in mint fields began in 1967.

"Of all the chemical weed killers studied, terbacil (Sinbar) looks best. In some cases it has completely eliminated the need for cultivation," says Lacy.

In field tests at the MSU Muck Farm, Lacy found that mint fields treated with terbacil had a 90% survival rate after 2 years even though the fungus causing Verticillium wilt was present in the soil. Cultivated plots at the same location had only 70% survival rate during the same 2 years.

"Those experiments were conducted with the old susceptible mint variety," notes Lacy. "If growers combine chemical weed control with the new wilt resistant variety, the survival of mint plants could be pushed nearer the 100% mark."

NO WEED CONTROL



WITH HERBICIDE
The mint oil smells better.

Even though the new resistant mint variety and new herbicides show promise of greatly reducing Verticillium wilt problems, Michigan is not likely to see an immediate increase in mint acreage. "Mint growing isn't as profitable as many would think," Lacy says. "In the American mint industry each farmer does his own processing by distilling the oil out of the harvested mint plants — and mint still costs a lot of money." As a result, the price of mint oil will be the primary factor that determines whether or not Michigan regains its former reputation as the world's major producer of high quality mint oil.

COMPOUNDS FOR SCAB CONTROL

To prevent a 20% or greater loss in yields, Michigan apple producers have, in the past, sprayed their orchards for scab control as many as 16 times or more a year. However, the recent development of a new family of fungicides has made MSU plant pathologist Dr. Edward Klos and his colleagues hopeful that apple scab, as well as several other fungus diseases, can be controlled more easily in the future.

Since the new systemic fungicides work inside the tree's circulatory system, the chemicals are not washed off by rain and tend to provide control for longer periods. Thus it should be possible to stretch the amount of time between sprays. MSU plant doctors are now investigating how long the interval between sprays can be extended.

Systemic fungicides also reduce the ability of the fungus organisms to survive through Michigan winters. "Tests indicate that it may be possible to apply one of these compounds in late October and drastically cut the amount of fungus available to start a new disease outbreak in the spring," notes Klos. With lower numbers of disease fungi present, one application of fungicide in the early spring could provide control for an extended period, reducing the need for more spray applications even further.

Compounds that can cure or eradicate fungus diseases rather than just prevent them have also attracted the attention of Klos' team of plant pathologists. "With compounds like this you can wait until conditions for disease development occur before spraying," says Klos. "Timing is important though," he points out, "if you wait too long the sprays may not provide satisfactory control."

Apple Scab Fungus Always Changing

Recent laboratory investigations of the apple scab fungus, *Venturia inaequalis*, show that different strains of the fungus may have different levels of sensitivity to fungicides. These studies, conducted by MSU plant pathologist Dr. Edward Klos and his assistants, showed that the sensitivity level can be passed on from a parent fungus to its offspring. The reason for the different levels of sensitivity is still unknown. Tests are now being conducted to determine the effect that small differences in fungus sensitivity to fungicides might have on disease control in commercial apple orchards.

FIGHT FIRE WITH FIRE

Fighting fire with fire could be the answer to the disease problem that has practically wiped out Michigan's pear industry. The disease is fireblight – a bacterial disease that reduces yields, causes poor fruit quality and often kills the tree.

The fire used to fight fireblight is a harmless bacterium that is antagonistic to its disease causing cousin. MSU plant doctors are studying the two organisms to find out why one suppresses the other.

Hopefully, plant pathologist Dr. Edward Klos and his colleagues may be able to tip the natural balance in favor of the harmless bacterium and provide a natural biological control for the disease.

Other Fire Extinguishers

Klos and his colleagues are also looking at growth retarding chemicals, better spray application schedules and spray additives that might reduce fireblight problems in Michigan. Because the disease attacks rapidly growing parts of the tree, growth retardants could have an important place in fireblight control programs. Several different growth regulating chemicals are now being studied to see what effect their use has on the development of fireblight.

Spray schedules for fireblight control are being reviewed to find out when bactericides offer the best disease control. If the sprays can be effectively timed it should be possible to keep disease inoculum levels down all the time.

Spray additives that could make the active chemicals in the spray more deadly to the fireblight bacterium are being evaluated and field tested "We are now looking at adjuvants (spreading agents and penetrants) in hopes that some of them may significantly increase the effectiveness of each spray application," Klos says.

OPPOSITE· DR. E. KLOS CONDUCTS
RESEARCH IN THE ORCHARD

DISEASE FREE CHERRIES

Since Michigan provides about one-third of all the cherries grown in the whole world, diseases are an important problem for cherry growers throughout the state. To help solve these problems MSU plant doctors conduct research studies on each disease that attacks Michigan cherry orchards. They also evaluate new chemicals that show promise for controlling these diseases and compare their performance to older, commercial chemicals.

Cherry leaf spot is possibly the most important disease attacking Michigan cherries, so it has been the subject of a major research effort at MSU. According to Dr. Edward Klos, MSU plant pathologist, some progress toward better control of this fungus disease has been made. "Systemic fungicides offer control of the overwintering stage of the fungus – as well as during the growing season – thus reducing the amount of disease inoculum present in the spring," he says. "Then, our tests show that a single application treatment of fungicide, applied when the buds first show green at their tips, can control the disease organism until close to harvest," he says

This means growers would not have to apply nearly as many sprays to control cherry leaf spot for the rest of the season. Furthermore, some of the new systemic fungicides show promise of controlling other fungus diseases such as mildew and brown rot.

HOT BATHS FOR FRUIT

For humans a hot bath eases aching muscles, but for fruit a hot bath can prevent diseases.

According to Dr Alan L. Jones, Michigan State University fruit disease expert, increased use of mechanical harvesters has boosted efficiency in many Michigan orchards. It has, however, also caused an increase in the chances of post harvest disease problems – especially for cherry and plum growers.

Jones and Clyde Burton, USDA plant pathologist at MSU, recently started a research program aimed at developing methods of preventing the major post harvest diseases. The hot bath idea is one of their early results. "Treating the fruit by dipping it into 125° water looks like a good brown rot preventative," says Jones, "if the fruit gets a later chemical treatment to protect against reinfection during storage, shipping or at the store.

NEW CHEMICALS LOOK GOOD, TOO

According to Jones, some new experimental fungicides control brown rot more effectively than standard chemicals now available. The new fungicides provide a high degree of brown rot control when harvested fruits are dipped, drenched or sprayed with them.

By mixing the fungicides in hot water baths, Jones and Burton noted improved disease control over either method alone, with the advantage of protecting the fruits from reinfection.

Necessary equipment for commercial hot water or hot fungicide treatments have not been designed and perfected yet – a process that may take some time. In the meantime, Jones suggests that fruit growers consider cold water fungicide dips, drenches or sprays to maintain the quality of harvested fruit.

TESTING FUNGUS FOILERS

DR. A. L. JONES
The spore trap tells when to spray

DAREDEVIL CROP DUSTERS
Can their talents help fruit growers?

Since Michigan is one of the major fruit growing states in the U.S., MSU plant doctors conduct an extensive field testing program that is designed to evaluate the effectiveness of new fungicides and techniques for their use.

Depending on availability of fruit trees and the type of test to be conducted, field study locations are chosen from cooperative commercial growers and MSU's outlying experiment stations.

In the past, field tests were largely concerned with fungus diseases of apples and cherries, particularly apple scab and cherry leaf spot. The tests, using both aircraft and ground spray rigs, are designed to compare the effectiveness of new, experimental chemicals to standard chemicals that Michigan growers use to treat the diseases.

"Just finding out which chemical does the job isn't enough, however," says Dr. A L. Jones, MSU plant pathologist. "We need to know if it can be used efficiently, if it is hazardous to the environment, when it should be applied and if it is compatible with other insect and disease control programs before we make recommendations."

One of the newest trends in orchard pest management is integrated control. These pest management programs for diseases like apple scab and powdery mildew combine information from disease organism monitoring programs, weather data, and the relative effects of fungicides. Continual evaluation of this information throughout the summer means that spray programs can be changed to cope with conditions that develop during the season. This means better disease control with fewer spray applications and less hazard to the environment.

VIRUS-FREE TREES

Thanks to MSU plant doctors, Michigan fruit growers now can buy many of their fruit trees on a virus-free basis.

MSU plant pathologist Donald Cation, deceased, led the effort to develop a system for producing virus-free fruit trees. After the technique was perfected the Michigan Department of Agriculture (MDA) adopted it as the basis for the state's current certified virus-free program for fruit tree nursery stock.

According to Dr. A. L. Jones, MSU plant pathologist, virus-free trees offer better fruit quality, more vigor, rapid growth and lower levels of tree loss in new orchards.

For nurserymen participating in the program, MDA checks their stock twice each year for visible symptoms of virus diseases and for other conditions that may reduce tree quality. In addition samples from budwood source trees are tested for virus diseases. MSU plant doctors still assist in this program when new or unusual conditions develop.

The program was originally developed to help solve virus disease problems in cherries, but some nurserymen are now offering virus-free apple and peach trees, too

STONE FRUIT DECLINE STUDIED

For the past year problems in stone fruit orchards – primarily peach and cherry – have been a major concern of MSU plant doctors.

In 1972 the Agricultural Experiment Station formed a committee to investigate peach and cherry decline and to develop procedures for controlling or eliminating the problem. MSU plant pathologist Dr. A. L. Jones heads the research effort

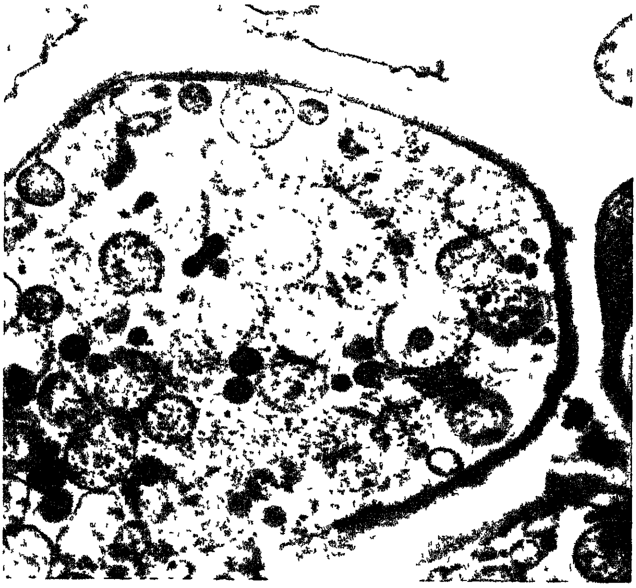
Originally, a virus or mycoplasma disease was thought to cause the decline. However, disease is only part of the problem. Physiological damage to the tree also plays a major role in stone fruit decline.

Major factors contributing to stone fruit decline are: X-disease; canker diseases, particularly *Cytospora* or *Valsa* canker, soil-borne diseases; winter injury; and mechanical damage caused by harvesting and thinning equipment.

MSU resources for X-disease research are concentrated in three areas: 1) develop a way to rapidly identify the disease, 2) determine how the disease spreads in Michigan, and 3) improve existing control methods and develop new control techniques.

DR. A. L. JONES WITH X-DISEASE

INFECTED SAPLINGS



A PEACH LEAF CELL
The round bodies are X-disease mycoplasm

Major accomplishments of the X-disease research include a state-wide program to eradicate wild chokecherry – a natural reservoir of the disease – and tests of the antibiotic compound tetracycline which may control the disease in infected trees.

MSU entomologist Oscar Taboada has been cooperating with Jones in attempts to determine how the disease spreads. Thirty-five different types of leaf hoppers have been found in infected orchards; four of these spread the disease in other states and are being used in X-disease transmission tests at MSU.

Jones says, "The primary non-disease problems are low temperature injury and mechanical shaker damage." Low temperature, or winter injury, not only reduces tree vigor, but can lead to canker diseases. Sometimes it kills the trees outright. Jones recommends that growers closely follow MSU recommendations for preventing winter injury.

Mechanical limb shakers used to thin or harvest fruit are also responsible for a significant part of the stone fruit decline problem in some orchards. To prevent excessive mechanical damage and related problems, growers should use extra caution during thinning and harvesting operations

Jones hopes to speed up stone fruit decline research efforts by organizing research workers through the Midwest. "We hope that a regional conference would make research efforts more efficient, and lead to an earlier solution to the stone fruit decline problem"

CANKER SOURS SWEET CHERRIES

Michigan experienced an outbreak of bacterial canker — a disease that attacks sweet cherries — in 1968 The disease reached epidemic levels in its first year. It has tapered off since then, but is still present in many orchards.

A team of MSU plant doctors led by plant pathologist Dr. A. L Jones completed diagnostic studies of the bacterial disease in 1971. Tests showed that two types of bacteria are responsible for the disease in Michigan One strain resembles the organism that causes bacterial canker in England, the other is similar to the one that causes the disease in West Coast fruit growing areas Now that the disease is positively identified, Jones has begun a program aimed at finding chemicals that would provide a means of controlling the disease.

The disease reduces the vigor of the infected cherry trees, leading to a general decline over several years. In severe cases, death of infected trees may result. It can also seriously affect yields by lowering the total numbers of cherries per tree and, lowering market quality of remaining fruits

Due to the potential problems this disease might cause if it spread into other susceptible fruit crops, care must be taken to prevent introduction of susceptible varieties of crops that might increase the level of the disease in the state.

SMALL FRUIT DISEASE PROBLEMS

Epidemiology is the study of the occurrence, distribution and control of diseases. To a plant doctor epidemiology is an important step in developing plant disease control programs that are practical and safe for farmers and home gardeners.

MSU plant pathologist Donald C. Ramsdell uses epidemiology as the basis for his studies of small fruit diseases. His current research efforts include disease of grape, blueberries, strawberries and bramble fruits such as raspberries.

Trampling Out the Vintage

A virus problem called degeneration disease is a major headache for Michigan grape growers. Not much is known about the disease, but MSU plant pathologist Donald C. Ramsdell believes a soil nematode transmits the disease from infected vines to healthy vines. To defeat virus diseases, Ramsdell is working with MSU horticulturists to establish "clean" stocks of Concord and French grape hybrids. This stock would insure that grape growers are not buying any virus disease problems when they purchase new vines.

Ramsdell also works with fungus diseases of grapes. "The new French hybrids entering the Michigan grape growing industry will be more susceptible to some fungus diseases than the domestic varieties grown in the past," he says. To avoid anticipated problems caused by the powdery and downy mildew diseases, Ramsdell is designing new disease controls for problems peculiar to the French hybrids.

Better Blueberries

A major fungus disease that plagues blueberry plantations in Michigan is mummy berry. Ramsdell's investigations of the disease are providing insights and new control techniques that may reduce the disease's impact on the blueberry industry.

"The secondary infection of the fungus begins to occur as early as the pink bud stage." Previously, it was thought to start later, thus many spray programs did not effectively control the disease. "Now that we know that secondary infection starts at pink bud and continues all the way through the blossom period, we can alter spray programs to give better control," the MSU scientist noted.

Ramsdell is evaluating the potential of new systemic fungicides for controlling mummy berry. Some show

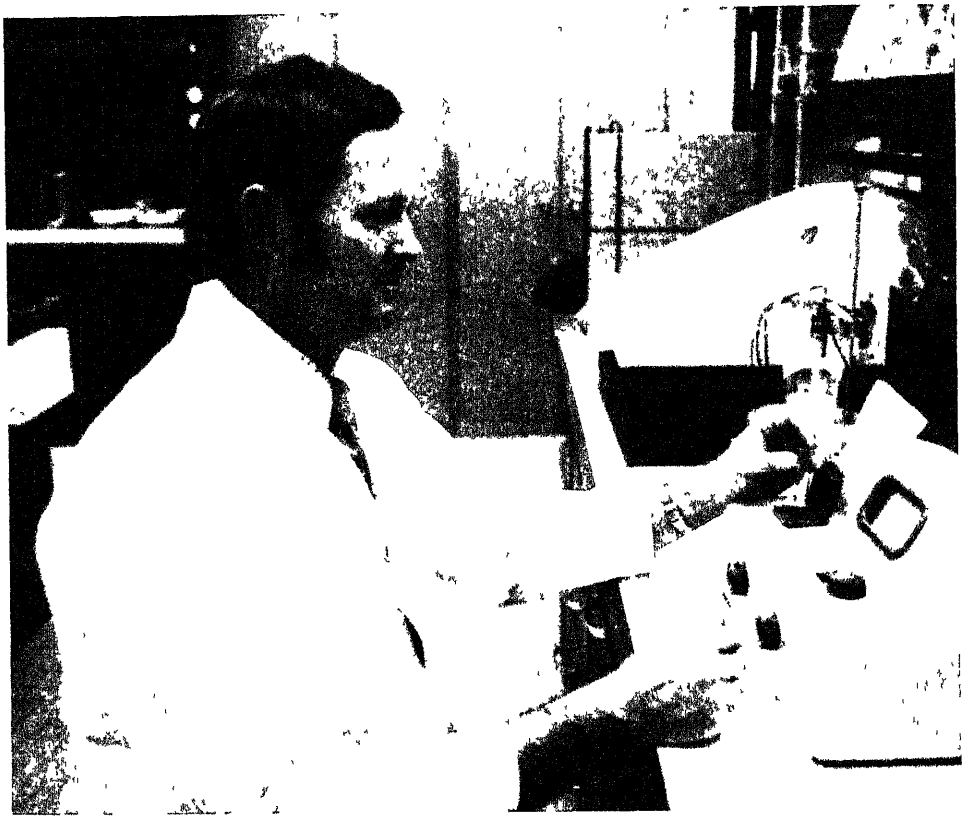
DR. DONALD C. RAMSDELL COMBATS DISEASES IN SMALL FRUITS

promise for preventing both primary and secondary infections and would provide control for longer periods of time than the old contact fungicides, thus reducing the number of required sprays. "The systemics would be a big boost for blueberry growers," says Ramsdell, "since only two fungicides are currently available for use in controlling secondary infection of mummy berry, and neither one is much more than 50% effective.

Ramsdell is also studying two major canker diseases that attack cultivated blueberry varieties. The project is only one year old but preliminary recommendations for canker control are expected within 2 years.

Strawberry Investigations

The primary disease problems that confront strawberry producers in Michigan are due to soil-borne fungus organisms and aboveground fruit rots. To combat the root disease problems Ramsdell is looking at the possibilities of fumigating soils with fungicidal compounds. Pre-plant treatments could offer protection from the complex of diseases that cause black root rot and the organism that causes Verticillium wilt. Fungicides that show potential for controlling the fruit rots known as gray mold and stem end rot are also being evaluated as part of the program.



DR. M. L. LACY
Putting the bite on blight

HEALTH CARE FOR HORTICULTURAL CROPS

PUTTING THE BITE ON CELERY BLIGHT

The key to putting the bite on blight is an on-going program at MSU that screens chemicals developed for control of late and early celery blights – the major fungus diseases attacking Michigan's 5 million dollar celery industry.

According to Dr. M. L. Lacy, associate professor of botany and plant pathology, the objective of the research is to continually update celery spray recommendations so that growers can use materials that offer good blight control with minimum danger to spray applicators and the environment.

Lacy's tests are conducted under situations that resemble commercial growing conditions as closely as possible. The only major exception was that the celery plots were artificially inoculated with late blight fungus so the effectiveness of the chemicals can be better evaluated. "We tested all the chemicals that are currently approved for controlling celery blights," says Lacy. "On the basis of these tests we will recommend five compounds for use in Michigan."

The recently developed systemic fungicides have also received attention in the celery blight program. The experimental systemic Benlate appears to give control when used at one-third the total application rate of present control materials, and is only applied half as often. The primary advantage of Benlate is that it can stop the disease after it is established. This is unique because almost all the other chemicals are protectants, and must be present before blight outbreaks occur. If this compound, and other similar experimental systemic materials, are approved for commercial use on celery, both growers and the environment should profit.

AERIAL WAR ON DISEASE

"New advances in technology have made the airplane and helicopter effective tools for controlling vegetable and field crop diseases," says Dr Howard S. Potter, MSU plant pathologist. In the past only insecticides could economically and effectively be applied by aircraft, but now disease problems can also be attacked from the air According to Potter, three major breakthroughs have made aerial application a valuable tool for plant doctors and farmers:

1) The development of disease controlling compounds that remain suspended in water in high concentrations.

2) Disease control can be achieved with lower spray volumes — as low as 5 gallons per acre — making aerial spraying economically feasible.

3) New advances in aerial application equipment have made aircraft application of fungicides and bactericides more efficient.

Potter began studying the use of aerial spraying for plant disease control in 1964. Since then, the research program has resulted in recommendations for aerial applications of fungicides on beans, potatoes, cucumbers, tomatoes, asparagus and many other crops.

Controlling a disease from the air saves a lot of time. "At best, ground application using the most modern equipment available can cover 25 acres per hour," says Potter "Aerial application of the same chemical spray means covering 75 to 150 acres per hour, depending on the type of aircraft used."

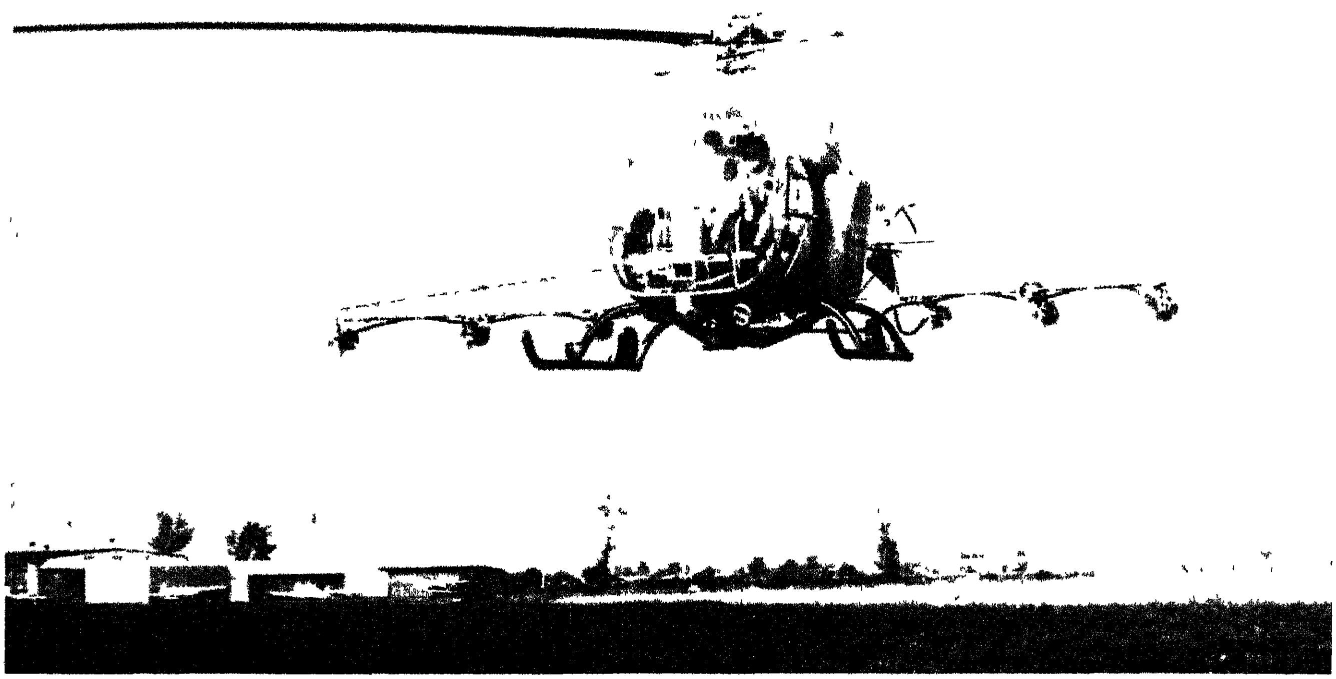
Since timing of spray application can be vital to good disease control, aerial application has another advantage over ground sprayers. "With aerial application a crop can be sprayed when the soil is wet and ground spray rigs can't get into the field," notes Potter. This is an important point since many fungus and bacterial disease outbreaks follow high moisture conditions. (In such cases the disease causing organisms depend on moisture for spread from plant to plant and for growth.)

The fact that the plants are not physically disturbed during aerial application is another plus "There is less opportunity for the mechanical spread of virus and bacterial diseases and direct physical damage to the plants is eliminated," says Potter.

Yield losses caused by soil compacting effects of ground spray equipment are often overlooked when talking about the advantages of aerial application. During 1971-72 Potter and his colleagues did a soil compaction field study on 12 potato farms throughout the state. Results of the survey show that yields in the rows next to tractor and spray rig wheel tracks were reduced by 20% or more "On the average, this meant a loss of $46 per acre," notes Potter, "assuming that a 14-row ground sprayer was used and that total yields were approximately 400 bushels per acre With aerial spraying these losses can be avoided completely

New techniques used in growing crops have also helped to increase the use of aerial spraying Many farmers who plant crops in narrow rows or in solid blocks have switched to aerial spraying for disease control because it is too difficult to get ground spray rigs into the field without damaging the crop Increased use of solid set irrigation systems (pipes remain in the fields for the whole season) has had a similar effect. Aerial application makes more sense in this case, because the irrigation pipes would have to be moved before ground spraying could be done.

DR. H. S. POTTER
A general in an aerial war



CAN NEW EQUIPMENT USED IN AERIAL SPRAY TESTS PROTECT THE ENVIRONMENT?

No Rose-Colored Glasses

Despite its advantages, Potter is careful to point out that aerial application does have some disadvantages when compared to ground spraying for disease control. Under certain conditions getting the spray from the aircraft to the plants can be a problem. When the winds get above 10 miles per hour, drift problems occur. Thermals (rising columns of warm air) can also redistribute small spray droplets, and if fine sprays are applied early in the morning they may never reach the crop. These occur when the air at ground level is cool and the air just above the crop is warm.

As a result, aerial application recommendations now call for larger spray droplets (the heavier the droplet, the less chance of drift) and lower total amounts of spray per acre. "We found that one drop of concentrated spray can protect a plant surface area many times its diameter, because it spreads out over a large area in the presence of water," says Potter. "This means that instead of 100 to 200 gallons of water per acre, we can now get the same disease control with only 5 to 10 gallons of water per acre."

Potter says that spray drift can also be minimized by including special additives in the spray tanks. Depending on the type, additives help give better spray coverage, reduce drift problems and keep the spray from evaporating before it gets onto the plants. Foam additives show special promise for reducing spray drift problems. The foam adds bulk to the spray and causes the droplets to fall faster so they are subject to wind for a much shorter period.

FOAM
Promise for reducing spray drift.

A MULCH IN TIME SAVES NINE

For years, mulches have been used to lower soil temperatures, preserve soil moisture and inhibit weeds. Now, however, mulches have been enlisted by plant doctors in the fight against vegetable diseases.

"Using plastic mulches in combination with soil fumigation can increase production of many vegetable crops," says MSU plant pathologist Dr. Howard S. Potter. "This practice can be particularly effective when early crop maturity is a must for getting the best price."

Black plastic was first widely used as mulching material, but Potter says there are good reasons why Michigan vegetable growers may want to switch to clear plastic. Black plastic was used because weeds would not grow under it. However, new broad-spectrum soil fumigants that help control weeds as well as soil insects and disease organisms, make the use of clear plastic mulches more practical than the old black plastic types. Also, the soil heats up faster under clear plastic mulches during the early spring. This means earlier maturity than when black plastic is used.

So far, Potter has compared the performance of several soil fumigants under both clear and black plastic mulches. Tests show that the combination of clear plastic mulches and broad-spectrum soil fumigants is very practical for high value vegetable crops. It does a good job of controlling diseases, insects and weeds, and boosts yields as well.

CLEAR PLASTIC MULCHES IMPROVE PLANT PERFORMANCE

BETTER, GREENER LAWNS

DR. J. M. VARGAS
And the green grass grew all around.

Each year plant doctors at MSU help keep Michigan's 400 million dollar turfgrass industry healthy by solving disease problems that affect sod production, home lawns, sport fields, roadsides, cemeteries and industrial and institutional grounds.

According to Dr. Joseph M. Vargas, MSU plant pathologist, most major diseases of turfgrass are caused by fungi. Problem diseases in Michigan include snow mold, *Fusarium* blight, dollar spot, striped smut, and powdery mildew. Over the past several years Vargas and other MSU turfgrass specialists have conducted research on these diseases to find better preventions and cures.

Snow Molds Aren't Fussy

Fungus organisms that cause snow molds can be a problem on bentgrass varieties, bluegrass varieties and even some grass species that are thought of as weeds The diseases get their names because they usually attack during the winter when the ground is covered with snow.

In 1969 Vargas and his associates evaluated 56 varieties of Kentucky bluegrass for resistance to both gray and pink snow mold Of the 35 commercially available bluegrass types in the test, only two showed significant resistance to snow mold. However, some genetically similar experimental bluegrass varieties from New Jersey showed good resistance during the test. Thus, it may be possible to breed new varieties resistant to the disease.

Vargas' work with the granular fungicide Chloroneb helped establish this chemical as an effective snow mold control, replacing older, more hazardous compounds containing mercury and cadmium. Field studies proved that Chloroneb can be applied up to one month before the first permanent snowfall. Previous snow mold treatments had to be applied just before the first permanent snow This meant the disease often went untreated if snows came early.

Putting the Bite on Fusarium Blight

According to Vargas, many people believe that *Fusarium* blight is the most serious problem facing the sod industry Until recently there was no known control for the disease, and no grass varieties are known to be resistant to it

Working with MSU entomologists, Vargas has found that *Fusarium* blight involves an interaction with a tiny worm that lives in the soil. "In our studies the *Fusarium* fungus by itself wasn't sufficient to explain the severe stunting of the top growth and root system shown by diseased grass plants," says Vargas. "We think soil nematodes may be weakening the grass plants to the point where they are very vulnerable to the *Fusarium* fungus"

Also, in preliminary studies, the use of nematicides in *Fusarium* infected turfgrass areas has shown a lessening of the disease symptoms.

The new systemic fungicide, benomyl, is the first compound to give satisfactory control of *Fusarium* blight in turfgrass. Vargas tested the compound for 2 years, and it has given good disease control when used as a drench (sprayed on the grass and then washed into the soil with water). Eventually, Vargas hopes to obtain good control of *Fusarium* with fewer applications and lower application rates of the chemical.

Stemming the Tide with Systemics

Dollar spot is a common fungus disease of golf course greens. To control it the greens had to be sprayed once every two weeks throughout the season. Now, however, systemic fungicides provide control with one spray a month because the chemical is inside the plants and not washed away or lost during mowing.

Another fungus disease, striped smut, is systemic in nature, so the old contact fungicides were ineffective. Before systemics came along, an outbreak of striped smut meant replacing affected turf areas. Vargas has also evaluated the effectiveness of benomyl for controlling striped smut, and published recommendations for using the chemical to control disease outbreaks.

Although systemic fungicides have helped tremendously in controlling turfgrass diseases in Michigan they may have drawbacks just like the compounds they replace. Vargas cites the disease powdery mildew as one example "For about a year and a half we got good powdery mildew control using a systemic fungicide, then the fungus developed resistance to the chemical"

"We found that systemics act very specifically, affecting only one vital system of the disease causing organism, whereas the older fungicides acted on many vital systems. So now we are developing disease treatment techniques that alternate systemic fungicides with contact fungicides. This means the disease organisms have less chance of developing resistance to any of the chemicals used during treatment."

While studying new chemicals that may control turfgrass diseases, Vargas looks beyond their potential for holding diseases in check. He also studies how chemicals break down in the environment, the effects of the chemical and its breakdown products on soil microorganisms and other animal life, and where the compounds go in the environment.

DR. JOHN H. HART
Sampling for Dutch elm disease.

TAKING A TREE'S TEMPERATURE

To understand better how American elm trees react to Dutch elm disease, MSU plant doctors are taking the temperatures of infected trees To do this, they measure how fast the tree breathes in air and gives off oxygen According to Dr. John H Hart, MSU plant pathologist, for a tree, respiration (breathing) is just like temperature is to a human If the rate of respiration goes up, something is wrong.

In the case of Dutch elm disease, the fungus that causes the disorder gives off a toxic compound Respiration rates in infected trees go way up before visible signs of wilting appear

How much water the tree loses into the atmosphere is also a good scientific indicator of sickness. Elm trees begin to lose water very soon after the fungus invades them Major losses occur when visible signs of the disease appear. In fact, the wilting and dead leaves are directly due to water shortages

INSIDE HELP FOR ELMS

A new systemic chemical – one that works inside the tree – has joined the fight against Dutch elm disease, says Dr. John H Hart, MSU plant pathologist. Out of all the benomyl treated trees included in Hart's 2-year field test, only one tree became infected with the disease. About 12% of the untreated trees included in the study for comparison developed the disease during the tests.

Hart's studies were conducted at seven different locations in Flint, Michigan, during 1970 and 1971. Treated trees received a spray of benomyl and an adjuvant, mixed in water (Adjuvants act like water softeners and help ensure good coverage of leaves and branches.) Sprays were applied late in the spring after the elms had leafed out so that the chemical could get into the trees' circulatory systems through the leaves. One spray gave protection for the whole season.

"This isn't a cure for the disease, however," Hart carefully points out. "It just provides one more method of preventing healthy elms from becoming infected."

This treatment is unique because it works directly on the disease causing fungus, where older control methods were primarily aimed at killing the elm bark beetle and thus preventing it from spreading the disease from infected to healthy trees

The field studies conducted by Hart and City of Flint employees have helped to obtain a federal OK for the use of benomyl in Dutch elm disease control programs. The Michigan Department of Agriculture has released this compound for Dutch elm disease control in Michigan

A TEST SITE IN FLINT
Benomyl soil injections were tested, too.

NATURAL ANTIBIOTICS HELP FIGHT DECAY

When injured, some trees resist diseases caused by invading germs, while others become infected. MSU plant doctors have been conducting experiments to find out the "how" and "why" of this plant world paradox.

According to MSU plant pathologist Dr. John H Hart, the non-living wood (heartwood) in the center of the trunk and limbs – often shows greater resistance to fungi and other wood-attacking organisms than does the living portion (sapwood). Also, some tree species show more resistance to injuries to sapwood than other species do.

By locally injuring sapwood portions of trees, Hart was able to compare decay resistance between different tree species and obtain a better understanding of the resistance mechanism. These experiments showed evidence that resistance to invasion by disease organisms is related to changes in the sapwood cells located next to the injury.

Hart and his colleagues also found that changes that occur near an injury are similar to the events that occur during heartwood formation. "As the cells break down and die certain chemicals are formed. Some of these chemicals act as antibiotics, and prevent disease organisms from getting a foothold in the tree," says Hart

In the future, Hart hopes to study how the living cells produce these natural antibiotics, and to isolate the individual compounds for comparison with similar compounds found in heartwood.

THE CITIZENS' SERVICE

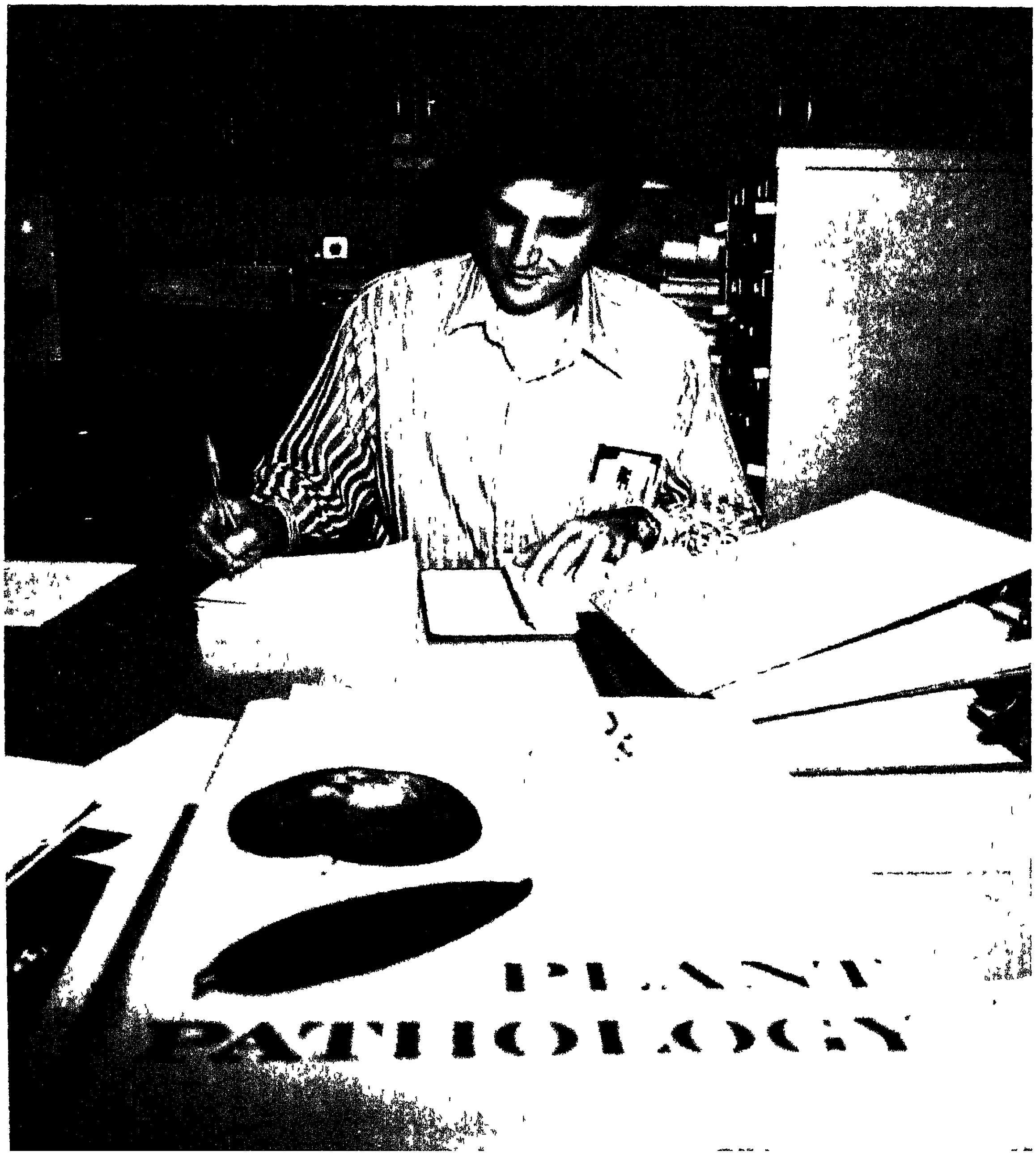
For more than 25 years MSU plant doctors have been helping Michigan citizens by identifying a whole host of new and old plant diseases that give farmers and homeowners headaches from time-to-time

MSU's Plant Disease Diagnostic Laboratory was originally established to help farmers identify diseases attacking their crops, according to Frank Laemmlen, MSU plant pathologist Since then, the Diagnostic Lab has turned more and more attention to the problems of home gardeners and urban and suburban homeowners.

The primary role of the Plant Disease Diagnostic Laboratory is to serve the public through the field staff of the Cooperative Extension Service. The Extension agents located in each county can often identify the disease without sending samples to the Lab here in East Lansing. If the agents can not tell what disease is causing the problem they know how to take samples of plant material, soil, etc, that the Lab must have to make an accurate diagnosis.

Laemmlen is responsible for the Lab's operation. He is aided by a technician, a graduate student, and five other extension specialists. Help is also available from research scientists in the Department of Botany and Plant Pathology who specialize in diseases of specific crops or types of plants.

DR. F. LAEMMLEN
Serving Michigan citizens.



SEX AND THE SINGLE GERM

MSU plant doctors are looking at the sex life of plant disease organisms, and their studies may have wide implications for the health of both plants and animals. According to Dr A. H. Ellingboe, MSU plant pathologist, the research began as a study of how disease causing organisms change. Particularly, changes not caused through the normal sexual reproduction of the organisms Twelve years later, however, the emphasis of the research has changed, too.

Scientists are now looking at the sexual incompatibility of pathogens (disease organisms) because there is evidence that knowledge gained in this area could lead to breakthroughs in plant and animal disease and health problems "At the basic research level there are great similarities between sexual incompatibility, host/parasite incompatibility and histocompatibility (the compatibility of tissues) in animals," quotes Ellingboe.

One beneficial result might be in host/parasite compatibility problems like those occurring in plant and animal diseases where imbalances in the relationship of the host and disease causing organism allow infection to occur. Another could be in the area of tissue grafts, organ transplants, and similar health problems, where compatibility is a must for success. "These three areas all deal with compatibility problems, but they are generally not thought to be related," says Ellingboe. "However, we now have some genetic evidence that leads us to think that these situations may turn out to be very similar." Thus, a breakthrough in one area could have great impact in the others.

NURSERIES FOR GERMS, NOT BABIES

In a nationwide effort to stop diseases in their tracks, MSU plant doctors maintain disease nurseries where crops from all over the U.S. are planted and evaluated for resistance to crop diseases. The nurseries are operated cooperatively with the USDA, and are located in nine places throughout Michigan.

According to Dr. A. H. Ellingboe, MSU plant pathologist, three major types of information come from the nursery studies:

1) New varieties from all over the world are evaluated as potential sources of resistance to various disease-causing organisms (pathogens) important in Michigan.

2) The nurseries provide a means of keeping track of any changes that could increase or decrease the ability of pathogens to cause plant diseases.

3) The checking system provided by the nurseries helps uncover situations in which a plant breeder may have accidentally developed a new crop variety that is very susceptible to a pathogen. (This is most likely to happen when a crop variety is developed in one region and grown in another where soil, weather, pathogens and other factors are different.)

DR. H. H. MURAKISHI WORKS TO DEVELOP A PLANT TISSUE CULTURE SYSTEM TO AID VIRUS STUDIES

NEW WAY TO DETECT VIRUS

For the past several years Dr. H. H. Murakishi, a virologist at MSU, has been working to develop a plant tissue culture system This system would enable plant scientists to study how virus diseases operate in plant tissues

"We have come up with a reliable system for studying viruses, particularly tobacco mosaic virus," says Murakishi. "It is designed so that plant cells used in the laboratory act very much like cells in a normal plant, giving certain symptoms in culture that are similar to those appearing in field situations."

According to Murakishi, plants that are susceptible to tobacco mosaic virus (TMV) show two general types of reaction to the disease. Some plants have a systemic reaction – where the virus is spread throughout the plant. Other plants are more resistant – virus spread is limited and lesions are found only near the initial point of infection.

Using the new plant tissue culture technique plant doctors can now study these two reaction systems. By comparing the two types of reactions they hope to find some explanation for the nature of resistance to virus diseases in plants.

The tissue culture technique has also given Murakishi some insight into the possible explanation of how TMV infects cells. The successes and failures that occurred during the development of an effective means of inoculating plant tissues with TMV, lead us to believe that virus particles may get into individual cells through the plasmodesmata," he says. (Plasmodesmata are fine strands of intercellular channels that pierce the walls of cells so that all cells are interconnected.)

The Best Bet

Two assistants on Murakishi's research team are looking at virus activity from another angle, using biochemical studies of the disease-causing particles. So far, they have found that TMV grows rapidly after being introduced into plant cells, and then suddenly "turns off." "If we can find the biological mechanism that 'turns off' virus growth, we might be able to someday breed the mechanism into crop varieties to give them greater resistance to virus diseases," Murakishi says "Right now, finding out what turns on or off virus multiplication looks like our best bet for making a major contribution to the control of virus diseases in plants," he says

ROD-LIKE VIRUS PARTICLES
Where's the on-off switch?

Impact at the Produce Counter

The MSU plant doctor has already cooperated with MSU horticulturists in the development of tomato varieties resistant to TMV. The scientists found that the tomato fruit symptom called internal browning is a shock reaction to the rapid buildup of virus particles in the cells.

Resistant tomato varieties have been developed and released in cooperation with Dr. S. Honma, MSU horticulturist.

GERMS AREN'T ALWAYS AT FAULT

Plant doctors do not always deal with diseases or natural injuries that make plants sick. Sometimes they have to cope with plant ills that the grower or gardener brings on himself, or are caused by the carelessness of a neighbor. A prime example of this case is improper use of herbicides (weed killers).

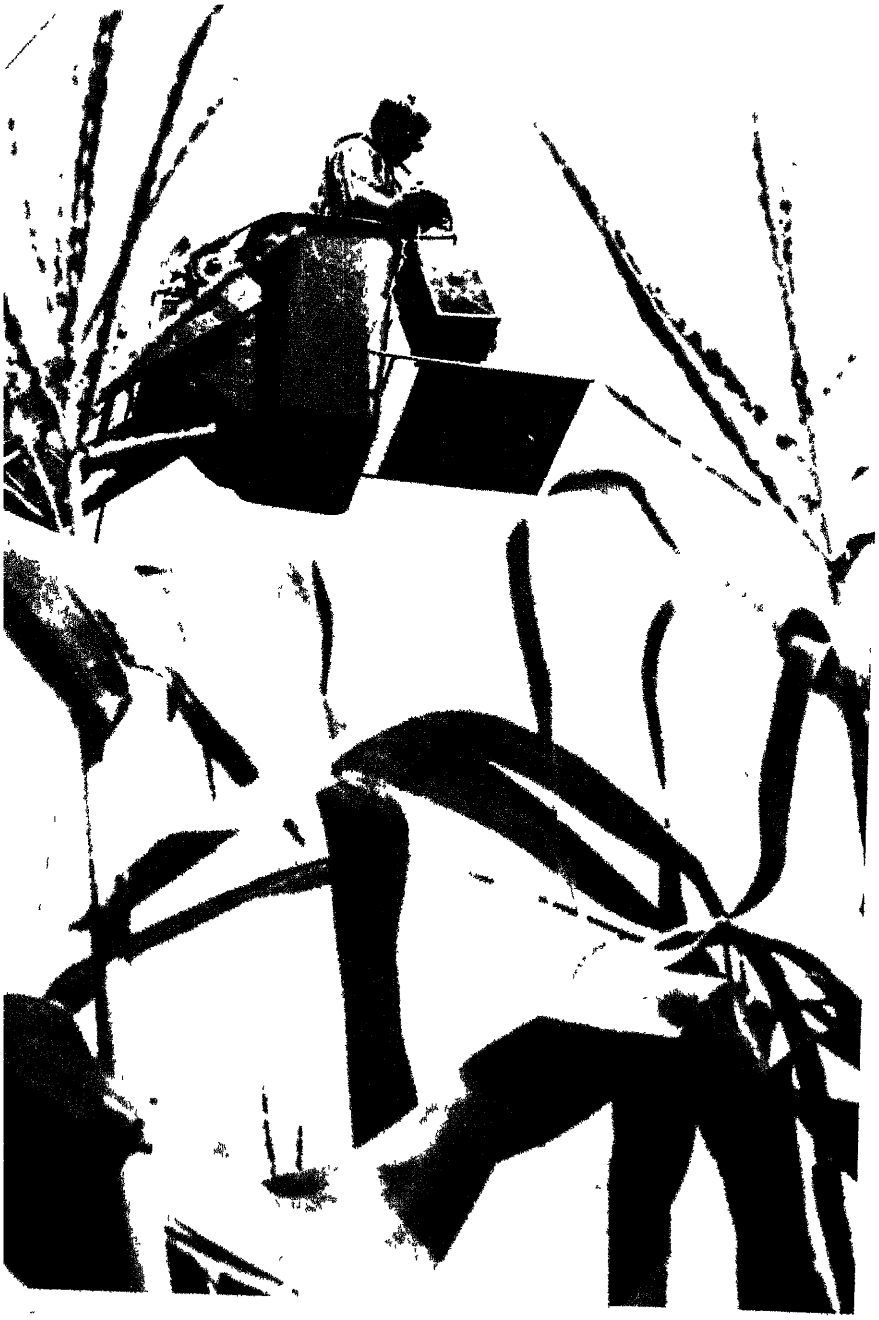
To help farmers and gardeners avoid herbicide damage problems, MSU horticulturist Dr. Alan R. Putnam and his colleagues conduct a continuous program of herbicide evaluation.

Using both laboratory and field tests, new herbicides are studied and compared to older herbicides already commercially available. New compounds are used at rates that farmers would use. The same chemicals are also used at much higher rates to determine the safety margin for the crop in question.

The ideal herbicide gives effective weed control at levels at least two or three times lower than the level that causes injury to the crop. "During the testing procedure we boost the rate until herbicide damage occurs," says Putnam. "This gives us a chance to see and record the injury symptoms so that they can be identified if they ever occur in commercial farm fields or in a homeowner's garden."

According to Putnam, the life of each new herbicide is followed from the time it is applied to the field until it disappears from the soil. A good herbicide disappears from the scene just before harvest time, leaving no residues in either the soil or the crop. It should also break down into harmless compounds that do not pose a threat to the environment. And, it should not react with other pesticides that it comes in contact with.

Using the information gained from this research, Putnam and his colleagues constantly update the list of herbicide recommendations that Michigan State University provides for Michigan agriculture.



DR. G. R. SAFIR
A sky-high spy

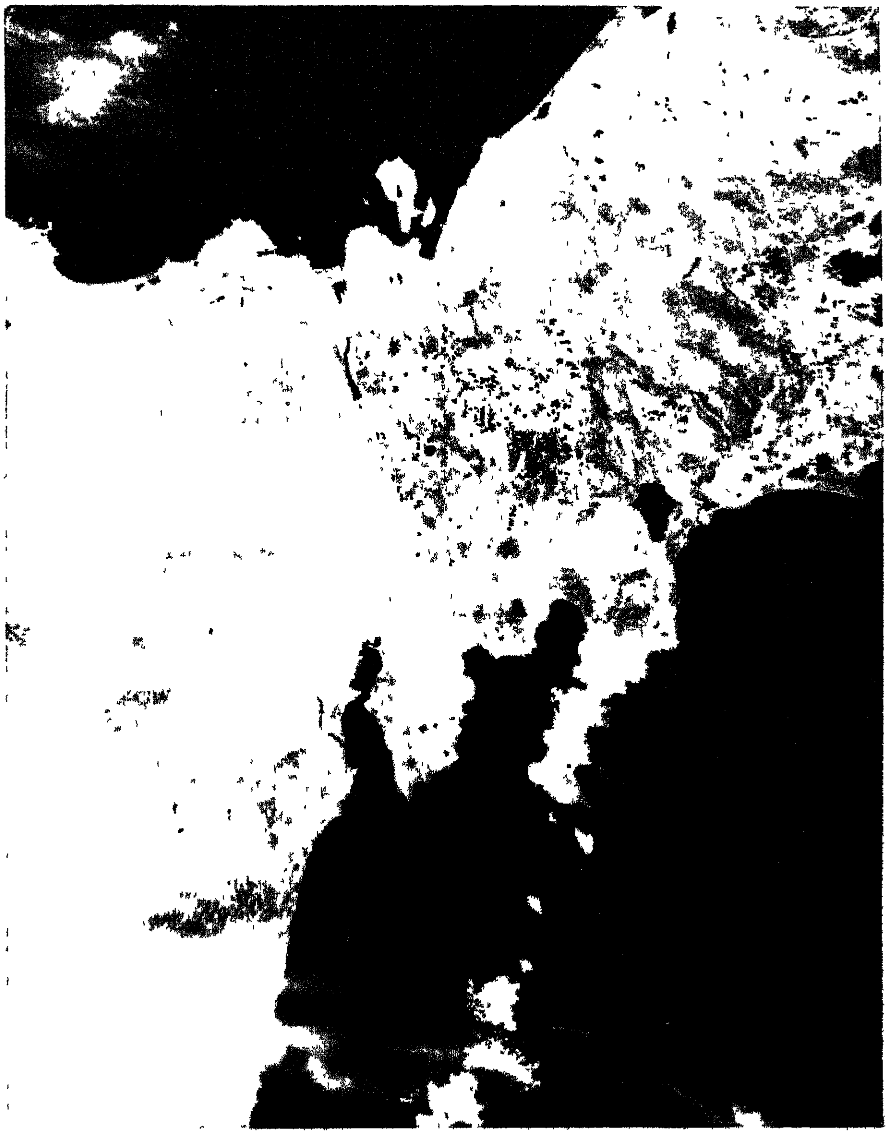
DR. A. L. ANDERSEN
Liasion between NASA and MSU.

SKY-HIGH SPIES SOLVE PLANT DISEASE MYSTERIES

Remote sensing is a space-age technique that allows scientists to get information about things from a distance, or things that can not be touched. This technique grew out of aerial photography and now includes all methods of obtaining information about things from a distance, such as radar, multispectral scanning, infrared photography, X-rays and sonar.

For 2 years now, MSU plant doctors have been studying the possibilities of using remote sensing for diagnosis of plant diseases and disorders. According to Drs Gene R. Safir and Gwynn H. Suits, MSU and Environmental Research Institute of Michigan (ERIM) remote sensing specialists, respectively, intensified food production and increasing world demands for food have created a need for rapidly detecting plant diseases over large land areas.

The cooperative venture between MSU and ERIM hopes to provide such a technique that could be incorporated into aerial and satellite surveys of major crop producing regions. MSU plant pathologists provide the necessary knowledge of plant biology and plant diseases, and ERIM scientists supply the needed technology and knowledge in remote sensing.



MICHIGAN (ESCANABA)
SEEN FROM ORBIT
ERTS satellite information — hope for better food production.

In 1971, Safir and his colleagues grew experimental corn plots, inoculated some of them with southern corn leaf blight (SCLB) to create small isolated epidemics, and recorded remote sensing data in the field.

Then Suits and other ERIM scientists flew their C-47 airplane over the plots at selected intervals to gather information on the corn's condition and the incidence of the disease. The C-47 carries advanced photographic equipment and multispectral scanning equipment that includes detectors that can measure the temperature of field crops. By comparing radiations collected with ground based instruments to the same sort of information collected during C-47 flights, a theoretical basis for a good system of remotely detecting corn diseases was developed.

Other corn diseases besides SCLB are being included in the project, and studies on wheat diseases have begun. Remote sensing studies of field bean diseases are also on the drawing board.

Experiments developed by the MSU/ERIM remote sensing team have also been included in two NASA programs — the Earth Resources Technology Satellite (ERTS) program and the Sky Lab Satellite program.

Information from the ERTS satellite is already available, and MSU scientists are analyzing the satellite data and comparing it to information collected on the ground.

DR. D. J. DE ZEEUW (RIGHT) AND TECHNICIAN CRUM
The treated seeds survive.

A SPECIALIST IN SPECIAL PROBLEMS

Plant diseases caused by fungi living in the soil create special problems for plant doctors.

According to Dr. Donald J. deZeeuw, MSU plant pathologist, the ideal method of controlling disease is to make the crop genetically resistant. However, there are so many diseases caused by soil fungi that attack seeds and young plants that it is impossible for plant breeders to develop varieties that are resistant to all of them.

So, the next best defense against these diseases is seed treatment. This is perhaps the most economical use of an agricultural chemical. It also reduces the chances of harming the environment to the lowest possible level. And, for the farmer, it provides an inexpensive means of insuring that his crop will get off to a good start.

Each year deZeeuw looks at about 50 chemicals that show possibilities for use as seed treatments; comparing old, established chemicals to new ones and looking for those that provide the safest, most efficient means of preventing diseases of seeds and seedlings. Combinations of promising chemicals are also evaluated as potential seed treatments. Over the years, deZeeuw has examined over 500 different seed treatment compounds.

A Million Dollar Bottleneck

The only real problem with seed treatment as a means of preventing plant diseases is that chemicals used for seed treatment do not pay big returns to the manufacturers. With the increased interest in protecting the environment it has become very difficult, and perhaps rightly so, to get federal approval for the use of agricultural chemicals.

In the process of getting a federal OK for a seed treatment chemical, the manufacturer now spends about a million dollars. And even if the chemical is approved, seed treatment sales may only amount to one boxcar load for the whole nation, compared to sales measured in carloads per county when regular sprays are used. For this reason, chemical manufacturers are reluctant to gamble on the economic risks of developing new chemicals for the small seed treatment market.

More Mellow Melons

In other research efforts, deZeeuw helps MSU vegetable breeders develop new disease resistant vegetable varieties especially adapted to the growing season and disease conditions in Michigan. "Currently we are trying to develop greater disease resistance in Michigan's famous Howell muskmelons, as well as working on other melon varieties that might have greater appeal in the national market," says deZeeuw.

He also participates in efforts to breed greater disease resistance into Michigan cucumber varieties, and is now working to confirm that the reason carrots will not grow properly in one major vegetable growing area of the state is that they are infected by a fungus disease similar to one recently identified in Wisconsin.

MELLOW MICHIGAN MELONS
Breeding in disease resistance.

Research in the Classroom

deZeeuw has found another unusual use for his research projects — in the 2-year technical study programs that MSU offers for Michigan farmers. "We use research projects to show farmers how different plant diseases can attack a crop and how different disease controls operate. Their interest in the basics of plant pathology is surprising, until you stop to consider that the modern farmer knows that controlling plant diseases can mean the difference between economic success and failure," deZeeuw notes.

Section 37.20, P. L. & R.

AGRICULTURAL EXPERIMENT STATION
MICHIGAN STATE UNIVERSITY
EAST LANSING, MICHIGAN

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FIRST CLASS

This is the 22nd in a series of "Science in Action" publications aimed at relating the research developments in specific areas within Michigan State University's Agricultural Experiment Station.

This publication summarizes some of the latest research information on plant disease studies.

We've also tried to show the areas of research to which we are committed and the prospective areas in which more research will be conducted.

For further information contact:

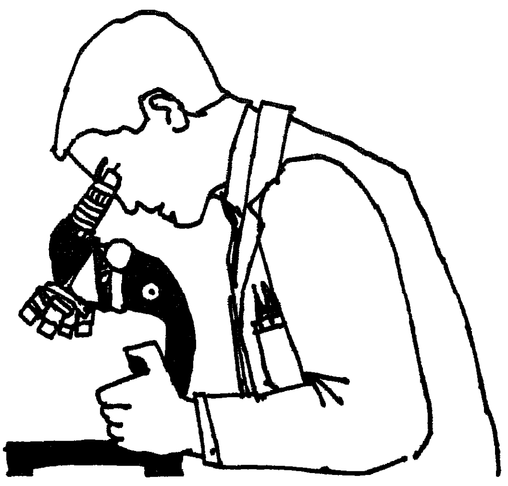
Dr. S. H. Wittwer, Director, Agricultural Experiment Station.

Dr. William B. Drew, Chairman, Department of Botany and Plant Pathology.

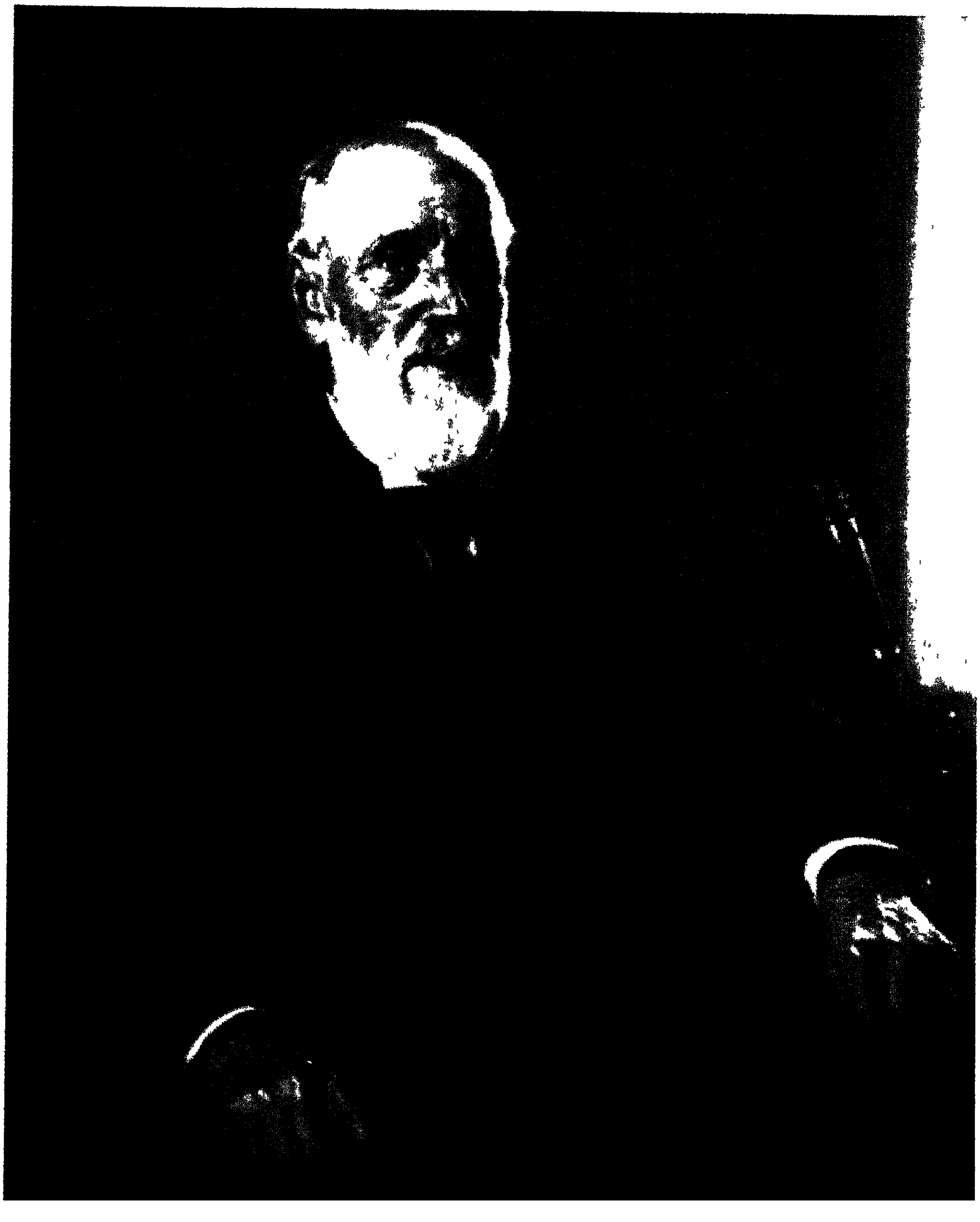
Dr. A. W. A. Brown, Director, Pesticide Research Center.

michigan SCIENCE IN ACTION

FROM THE MICHIGAN STATE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION, EAST LANSING
MAY 1973



23 Beal Centennial 1873-1973



100 Years Ago

In 1870 a young Harvard Graduate returned to his home state to become Professor of Botany at the new Agricultural College of Michigan The move led to an astounding, 40-year career that established William James Beal as an American pioneer in science, and brought prominence to the small college that was to become Michigan State University.

After his appointment to the MSU staff, one of the first enduring acts of Beal was establishing a botanical garden in 1873 The garden — recognized as one of the best of its type in the country — is a significant legacy to the university and Michigan, providing an ideal outdoor teaching lab and a focal point for flower lovers and naturalists Its founding was selected as the basis for the Michigan State University Beal Centennial — 1873-1973

The garden isn't all that the Centennial celebrates, however According to Dr. George Parmelee, MSU Curator of Woody Plants, "Beal was a jack-of-all trades and a master of most of them when it came to plant sciences." Beal also left his mark in the fields of forestry and horticulture And he taught ecology before the turn of the century and long before the public interest in environment

Other accomplishments included several books. One on the plants, or flora, of Michigan, the other, a major two volume work on the grasses of North America, was a standard reference book for more than half a century.

In spite of the various projects Beal managed to juggle and keep going during his 40 years at MSU, he still had time to teach — perhaps his most important contribution to Michigan and to the whole United States

OPPOSITE: W. J. Beal in his botanical garden in 1920 — 10 years after his retirement from MSU.

. . . in the 1880's

. . . 90 years later

One hundred years ago, Dr William J Beal — pioneer botanist, crop scientist and landscape expert at what was then the Michigan Agricultural College — planted about 140 species of native Michigan grasses and clovers in a ravine near the Red Cedar River

Four years later, in 1877, Beal expanded his garden to include a broader spectrum of plants grown in our state — wildflowers, shrubs, annuals, perennials and others.

Today, the Beal-Garfield Botanic Garden covers about five acres of Michigan State University's East Lansing campus and boasts more than 5,000 plant species It's the oldest continuously operated botanic garden in the United States

"Extensively redesigned in 1950, Beal Garden is now used primarily as a teaching aid. Horticulture students, future botanists, students of veterinary medicine, forestry majors and kids studying crop science all make good use of this facility," according to Dr George Parmelee, curator of MSU's woody plant collection

The garden also participates in a worldwide seed exchange program. Various seeds are collected and sent to botanic gardens and arboretums in many foreign countries

Three basic plant collections make up Beal Garden The systematic collection displays plans according to botanical family groups These plants are allowed to go through their complete life cycle to provide a more comprehensive learning experience for botany students

Another group, the economic collection, consists of plants that are important to man in either a beneficial or a harmful way

A large variety of beneficial plants are displayed in Beal Garden These include perfume plants, fiber plants, plants used for flavoring, medicinal and dye plants, Indian food plants, vegetables and ornamental flowers and shrubs The latter are used as study aids by the horticulture department

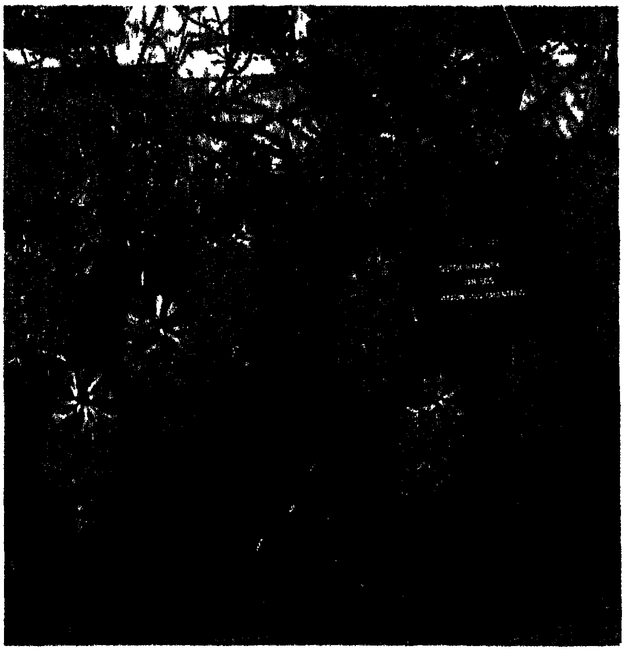
A special collection of weeds poisonous to livestock provide study material for the veterinary college Other harmful plants in the collection include mechanically injurious and milk-tainting plants.

The plants in the ornamental collection are not grouped formally like those in the systematic section and other categories of the economic system Instead, they are planted in a layered, natural arrangement for aesthetic value.

Beal Garden's third collection is made up of native Michigan plants grouped into common ecological communities, such as the beech-maple community These plants grow in a naturalistic setting on the garden banks

A self-guiding labeling system giving both general group and species names makes it easy for students and visitors to enjoy and understand the garden, which is open year-round.

These plant labels allow students and visitors to conduct their own self-guided tours. The labels provide common and Latin names for each species and sometimes information about the use or economic importance of the plant.



Besides his botanical garden, Dr. William J Beal had other horticultural influences on the MSU campus and throughout the state.

When Beal first came to the university he was asked to "double in brass" — holding the professorship of horticulture as well as the professorship of botany In this capacity he laid out and constructed the original system of campus roads and walkways Thanks to his foresight and his skill in landscaping, MSU's north campus is considered to be one of the most naturally beautiful campuses in the United States.

Throughout his tenure on the MSU campus Beal planted and tended trees and shrubs on the main campus His expertise as a landscape gardener won him fame and provided the basis for many of his public talks and articles in the popular press. During his own time the campus became a tourist attraction and Beal compiled a guide to the campus trees and shrubs to aid visitors in their excursions

Dr. Ken Sink conducts research on breeding new poinsettia varieties and on commercial production of these popular holiday season flowers.

Beal's horticultural contributions were not limited to the aesthetic use of plants, however He conducted research to improve both fruit trees and vegetable varieties

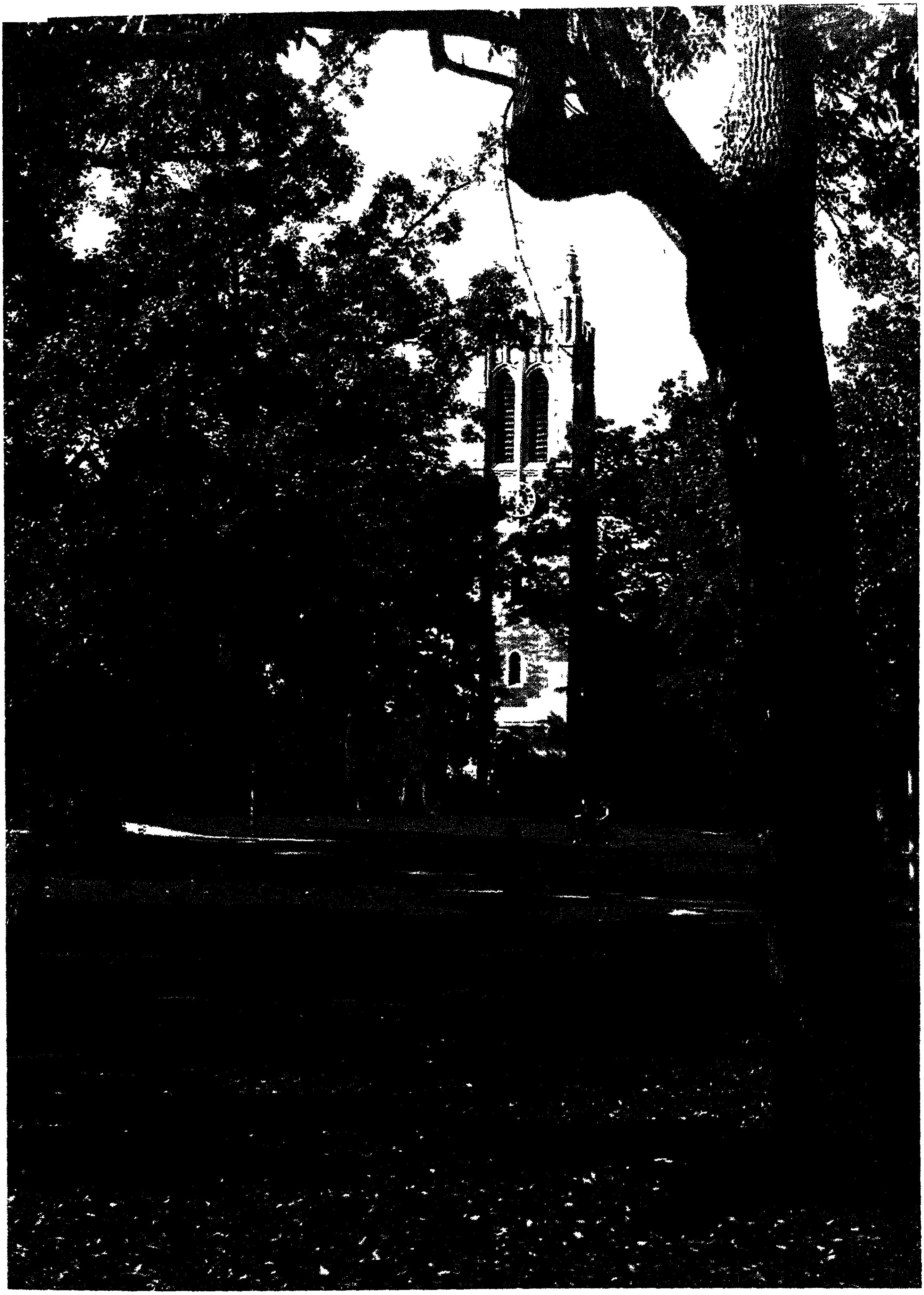
His influence was extended to the surrounding area in 1899 when he became the "pathmaster" responsible for road improvement in the region surrounding the campus

In the 1870's, Michigan was already a major apple producer. Beal worked to improve the position of apple growers by selecting and isolating improved varieties. He served state and national horticultural organizations in various capacities, including the Michigan State Horticultural Society.

In 1881 Beal was elected secretary of the American Pomological Society — a position he filled for four years. He was also in great demand as a speaker at horticultural meetings throughout the northeastern and mid-western United States

As in his work with field crops, Beal's horticultural research was influenced by Charles Darwin's theories of evolution and genetic inheritance In early experiments he examined the effect of crossbreeding on various vegetables and evaluated their potentials for agricultural production. This work led him to evaluate the germination ability and vigor of vegetable seeds sold commercially throughout the state — one of the university's earliest consumer protection activities

Today, MSU scientists still pursue the same objectives that Beal did The state's horticultural importance has expanded and become more varied Horticultural investigations now include grapes, vegetables, tree fruits, and flowers, to cite a few areas. By continuing in the tradition of Beal, MSU has developed new fruit and vegetable varieties that provide better quality as well as more efficient production on the farm. Some examples include the Haven peach varieties that are grown throughout the world, the Howell muskmelon, and Spartan carrot varieties.



The natural beauty of MSU's main campus is widely acclaimed. Much of the credit for this heritage is due to W. J. Beal who laid out the first formal roads and walks.

Nearly a century ago, William J Beal was conducting corn breeding experiments in a quiet campus setting in Michigan. The campus was Michigan Agricultural College, now Michigan State University in East Lansing.

The idea of crossing corn varieties to get a hybrid more vigorous and more productive than either parent originated with Charles Darwin who is more famous for his Theory of Evolution. In 1876, Darwin published "Cross- and Self-Fertilization in the Vegetable Kingdom " After reading the book, Beal wrote to Darwin who replied saying, among other things, "I'm glad that you intend to experiment." Beal cherished this letter He had it framed and kept it in his office for many years.

A plaque on the MSU campus memorializes Beal's contribution to the history of hybrid corn in the United States. It states in part "Near this spot in 1877, Beal became the first to cross-fertilize corn for the purpose of increasing yields through hybrid vigor. From his original experiment has come the 20th century miracle — hybrid corn."

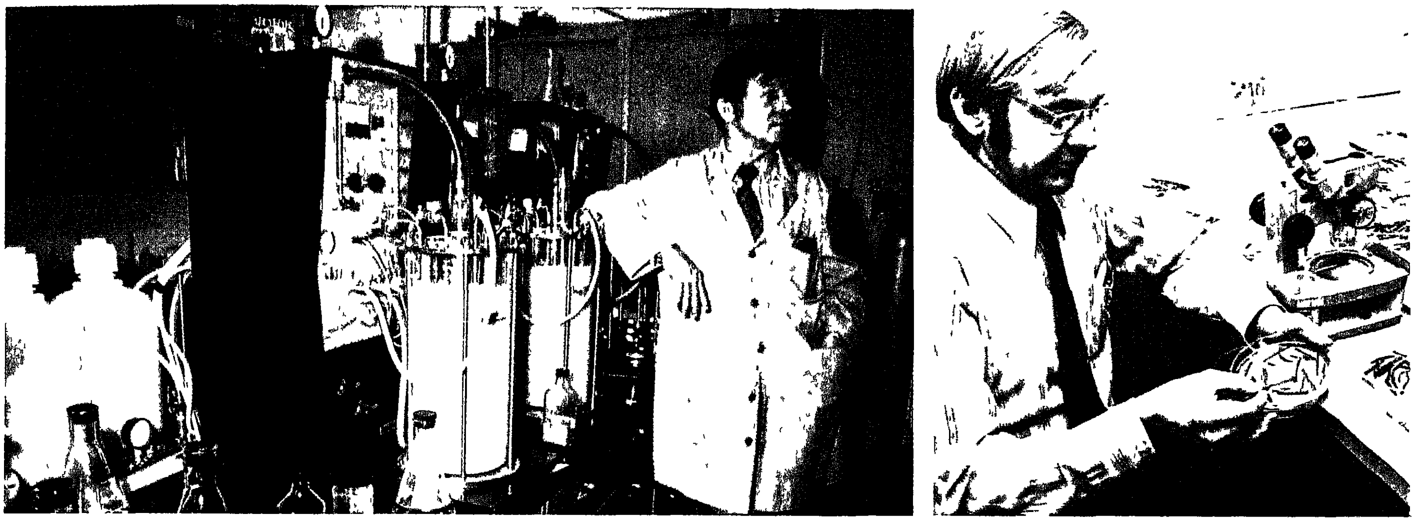
These improvements in corn are a part of the foundation that has made this crop one of the most important in the United States and the mainstay for human and livestock diets throughout the world.

A team of researchers at MSU continues to pursue the studies of corn started by Beal.

Following in Beal's footsteps, MSU scientists Drs. Dale Harpstead (foreground) and Elmer Rossman attempt to improve present corn hybrids by boosting their nutritional value (The smaller, lighter colored ear is high lysine corn.)

Better hybrids are produced each year. MSU's Agricultural Experiment Station has released 25 hybrids just since 1948. Since then, Michigan's average yield has more than doubled. Yields on some MSU plots were over 200 bushels per acre in 1972.

Planting good hybrids pays off, reports Dr. Elmer G. Rossman, MSU corn breeder In MSU's statewide trials, good hybrids out-produced the poor ones by 30 to 40 bushels per acre.



(Left) Taking the lead from Beal, modern MSU scientists like Dr. Hugh Henderson, seek ways to make nature work for mankind. Henderson and his colleagues have pioneered many advances in feed additives for corn silage that boost livestock performance (Right) Dr Albert H. Ellingboe probes corn infected with a new strain of Southern Corn Leaf Blight The new blight could cause extensive damage to Michigan's corn crop.

MSU researchers are also experimenting with high lysine corn, which has especially high nutritive value. Dr Dale Harpstead, now chairman of MSU's Crop and Soil Sciences Department, worked with the Rockefeller Foundation in South America to improve cornmeal diets for humans suffering from malnutrition While Harpstead is no longer actively engaged in this research, Dr Rossman is continuing to incorporate the high lysine characteristics into Michigan-adopted varieties

The battle to improve and maintain a crop is never won. Recently, the nation's corn crop has been attacked by southern corn leaf blight (SCLB). Researchers help farmers fight the blight by developing varieties that are resistant to it. County extension agents urged farmers to plant these resistant varieties — "N" or normal cytoplasm corn As a result, SCLB damage was almost zero in 1972.

But there may be a new blight threat. Dr. Albert Ellingboe and colleagues in the Department of Botany and Plant Pathology found blight in corn hybrids that were believed to be resistant. Drs. Ellingboe, Rossman and others are working to get varieties resistant to the new blight so the problem can be headed off before it gets worse

Radically new corn cultural practices also orginated at MSU. In 1940, Dr. Ray Cook, MSU soil scientist, began urging farmers to use minimum tillage practices to reduce hours of field work while minimizing soil erosion. Today, this plow-plant method of corn culture is sweeping the nation

Some farmers go a step further by planting corn right in the sod — no plowing or tillage whatsoever MSU specialists encourage this practice only if moisture is adequate at planting time.

On MSU's south campus, in the beef and dairy barns, animal scientists are improving corn rations. Dr Hugh Henderson, MSU beef researcher, says more beef per acre can be produced from feeding the whole corn plant because there is nutritive value throughout the plant.

Corn silage, especially with nonprotein nitrogen silage additives, is one of the most economical high protein feeds for ruminant animals. MSU researchers pioneered in testing nonprotein nitrogen additives like Urea, Pro-Sil and ammonia mixed in water.

If Dr. Beal were alive today, he might be excited about all these findings. But he would probably not be surprised. Known as an extremely perceptive individual, he taught his students to learn as he had learned — through observation.

A Quaker, Beal was noted for his austere manner as well as his love of pure science. He was also concerned about control of weeds, like quackgrass, which hamper crop production.

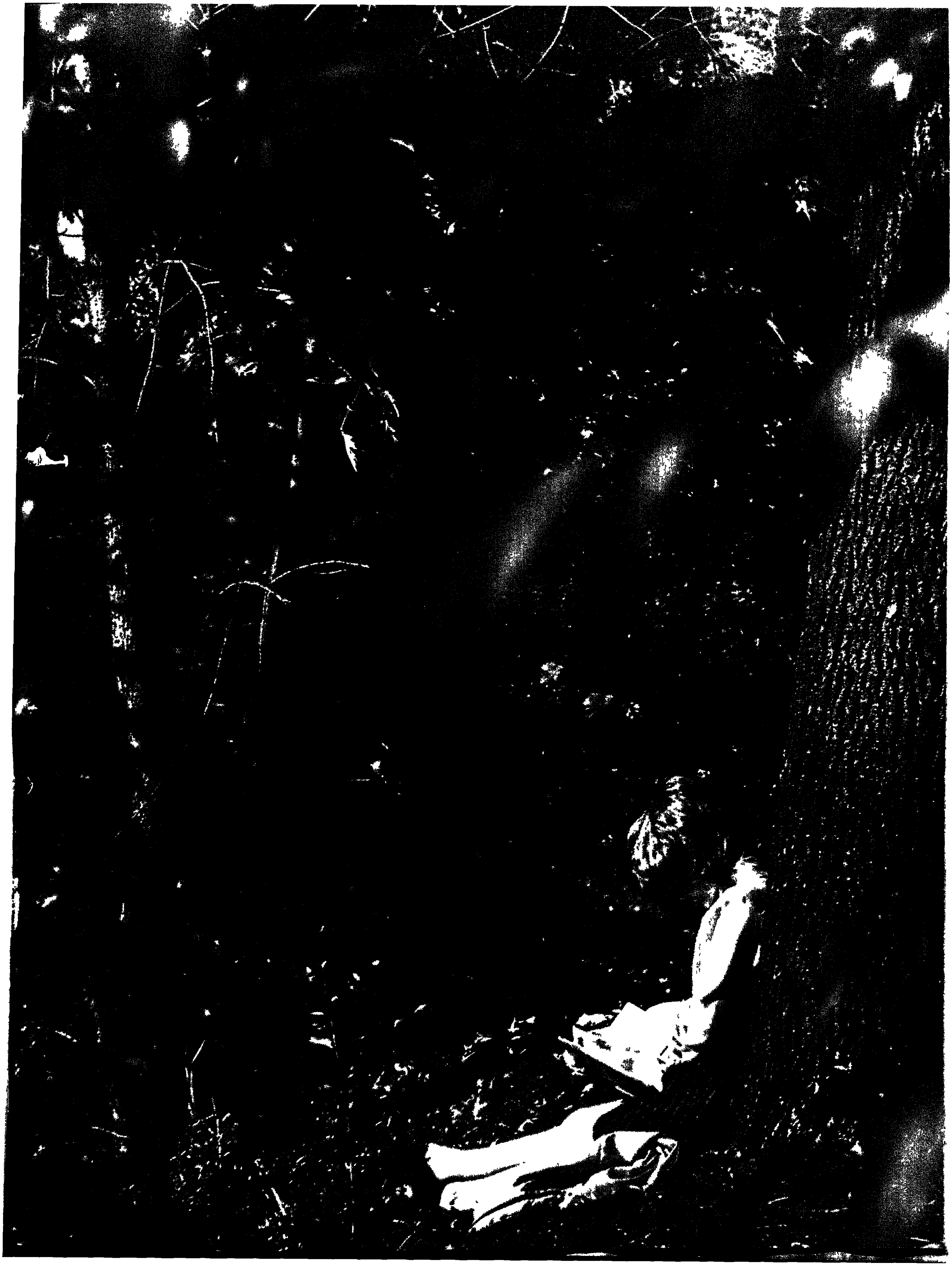
Beal's son-in-law, Ray Stannard Baker, once remarked that the pioneer scientist had "only three enemies in the world: alcohol, tobacco and quackgrass."

Sanford Natural Area is part of the original piece of land purchased in 1855 as the site for the Agricultural College of the State of Michigan The major tree species present throughout the history of the woods are representative of the vast beech-maple forest that once covered most of lower Michigan The 35 acres now contained in the forest have never been cut off. It is not virgin woodland, however, since it was managed for 65 years after the founding of MSU as a demonstration of forestry practices for farm woodlots

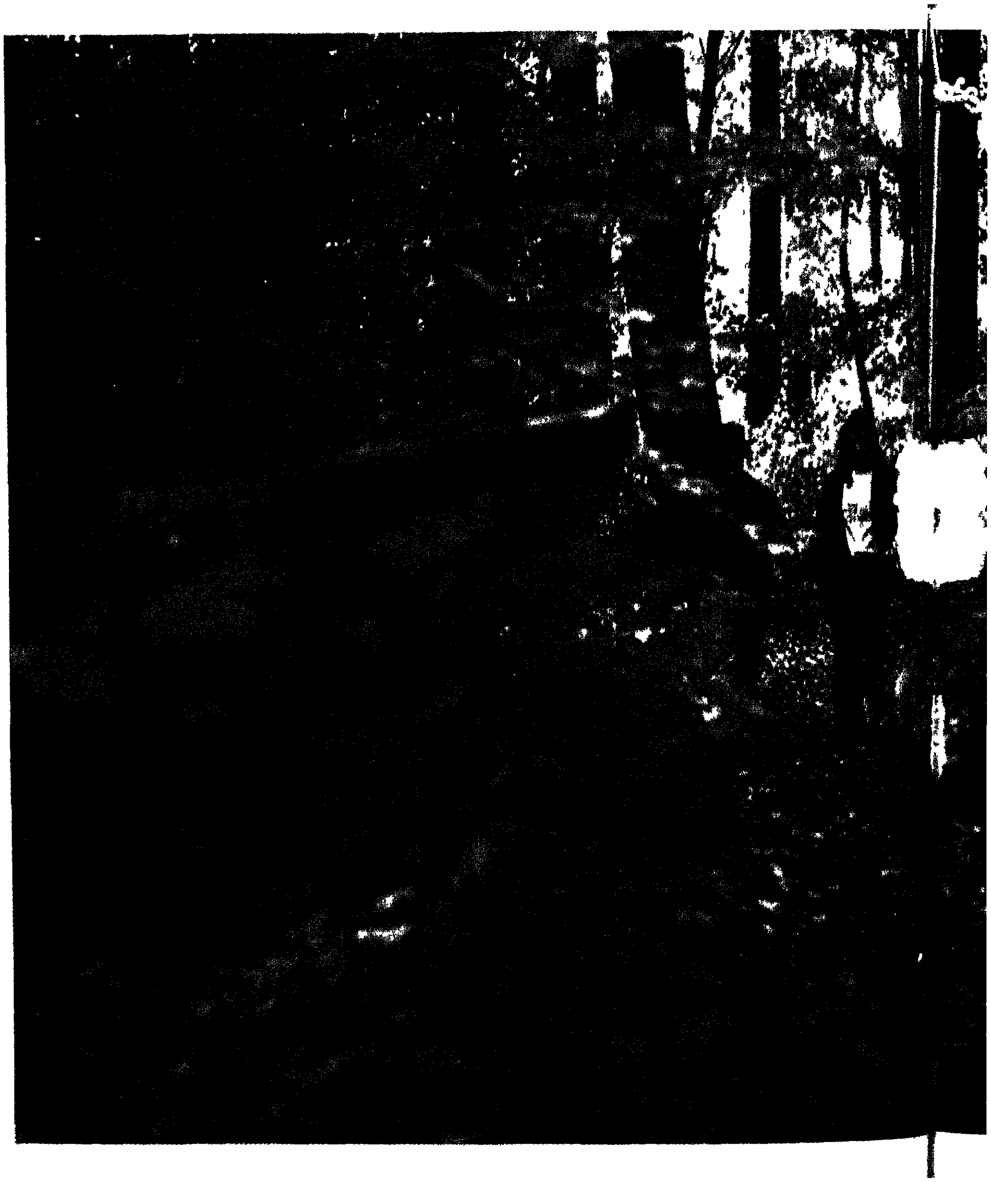
Dr William J Beal undoubtedly often visited the Sanford Natural Area and conducted some botany investigations there Although there is no record of Beal having direct influence on the woods, many modern MSU botanists and foresters believe that Beal was instrumental in the early development of the area

"There are signs of his influence throughout the area," said Dr. George Parmelee, MSU Curator of Woody Plants "The fact that the original woodlot was divided into 'wards' is typical of Beal's then radical views on forest management and conservation Also, the area contains many species of wild forest plants that Beal may have transplanted there after collecting them at other locations in the lower peninsula"

OPPOSITE: Sanford Natural Area—a place where students and local residents can escape for study, contemplation or relaxation.



In 1915 this sugar house was a brand new feature of the Sanford woodlot It remained there until 1960 and provided the basis for many maple syrup research projects.



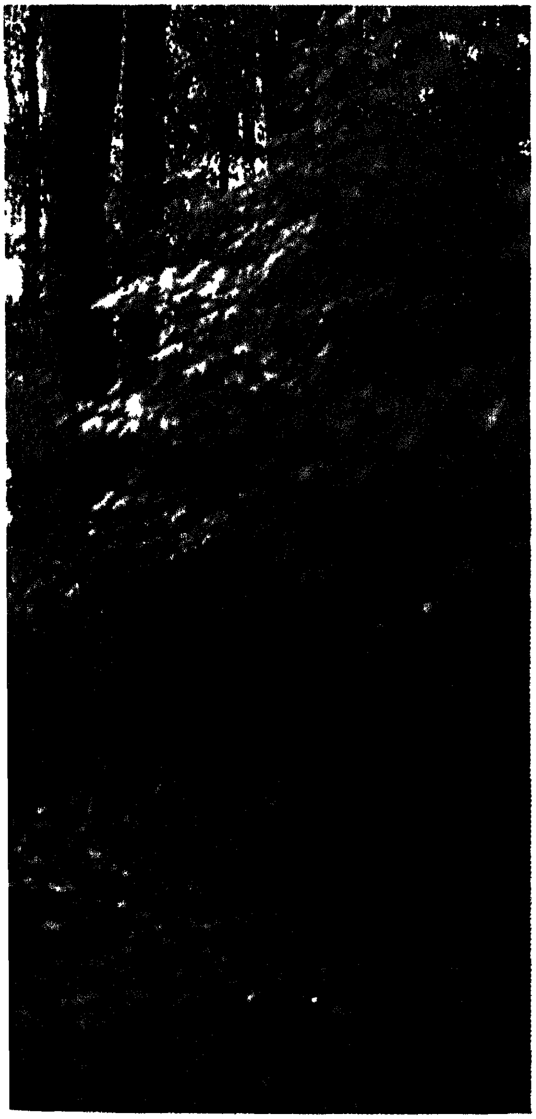
Heavy traffic problems in the Sanford Natural Area have abated recently with student efforts to preserve the woodlot.

At the very least, Beal influenced the management of Sanford Natural Area through his appointed role as a consultant In 1894, the State Board of Agriculture placed the management of campus woodlots under a professor of agriculture who was guided by Beal, then professor of botany and forestry.

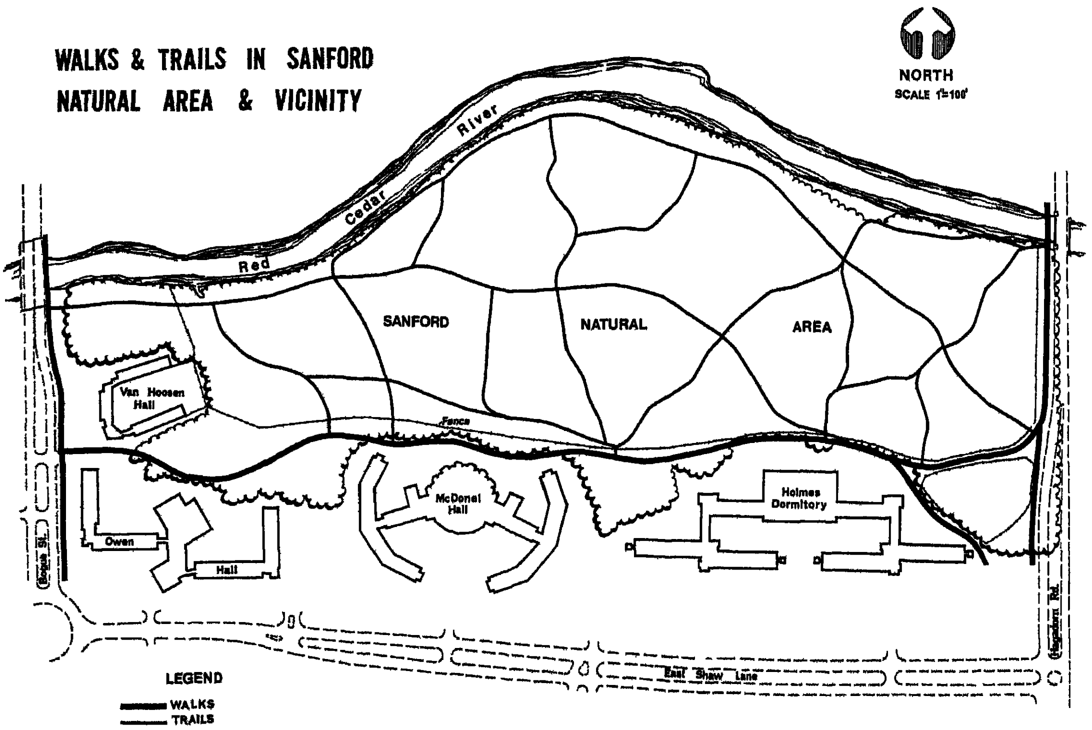
In 1915 the woodlot was first used for syrup production. A sugar house for boiling the sap was erected and research projects were initiated aimed at increasing the utility of maple syrup production as a side-line activity for farmers

Early research efforts were related to the effect of varying numbers of sap collection buckets on sap flow. Over the years, however, the research was broadened to include other problems related to the operation of a sugar bush The Sanford maple trees were tapped for the last time in 1960 Since then the woodlot has been left to the natural cycle of growth, death and decay. Its primary use is now in the teaching and research areas of the departments of botany, resource development, and fisheries and wildlife

The value of the Sanford Natural Area is further increased by its unique location On the north it is bordered by the Red Cedar River and Grand River Avenue in East Lansing On the south and western edges of the area are four major university student housing units. The eastern boundary is formed by Hagadorn Road



Harbinger of Spring — a rare wildflower found in the Sanford woodlot.



An adequate system of trails helps funnel heavy student traffic through the Sanford Natural Area with a minimum of damage to the native plants and wildlife.

The proximity of large numbers of people to the woodlot make it an invaluable aesthetic and recreational resource. It is unfortunate, however, that these same people pose the greatest threat to the Sanford Natural Area

"With the completion of the dormitories along the south edge of Sanford, the pedestrian traffic through the woods has increased tremendously," Parmelee noted. "It has reached a level that threatens to drastically reduce the variety of plant and animal life in the area. Already some less hardy plant species have disappeared from the area."

Ample trails are provided throughout the Sanford Natural Area, but new ones are occasionally made. Increased traffic has already, according to some specialists, made it impossible to conduct certain types of experimental investigations.

Parmelee said that proper protective measures are needed to preserve the Sanford woodlot's natural state and to save about 30 species of rare plants that still exist there.

"A massive education program aimed at informing MSU and East Lansing residents about how forest areas can be damaged is part of the answer," said Parmelee.

Sanford's foreseeable future isn't all grim, however. Student interest in preserving the natural area promises to help solve some of the problems that the woodlot currently faces

MSU's Lyman Briggs College is located in Holmes Hall — one of the residence halls that borders on the Sanford Natural Area. According to Parmelee, "Lyman Briggs students have been a big help in preserving the Sanford Natural Area. They often clean up bottles, cans and other trash, have helped to improve the current trail system, and clear fallen trees that block the paths."

On April 20, 1970, scientists dug up a bottle of seeds which had been buried on the Michigan State University campus for 90 years. After careful preparation the seeds were planted and MSU botanists became the proud parents of 90-year-old weeds.

This experiment, begun by Dr. W. J. Beal in 1879, is now the granddaddy of American seed vitality studies. Beal said that he wished "to learn something more in regard to the length of time the seeds of some of our most common plants would remain dormant in the soil and yet germinate when exposed to favorable conditions."

To accomplish this, Beal selected 50 seeds of 20 different kinds of plants. Twenty lots were prepared and mixed with sandy soil and placed in pint bottles. The bottles were then burried at a depth of 18 inches with the mouths slanting downward so that water would not collect in them.

According to Dr. Aleksander Kivilaan, MSU botanist now conducting the experiment, "The original plan was to dig up a bottle every 5 years and germinate the seed. However, in 1920, the interval was changed to 10 years to prolong the study." The Beal experiment represents the oldest continuing experiment at the nation's oldest college of agriculture.

The bottle of seeds dug up in April 1970 yielded only one species of plant — *Verbascum blattaria,* a weed commonly called moth mullein.

"In 1960 three species germinated," says Kivilaan. However, the fact that moth mullein is the only one to survive the test of 90 years is not unexpected. "There weren't very many plants of the other two species in 1960, indicating they might be nearing the end of their longevity," he says.

Beal's farsighted experiment has not only yielded important information on seed vitality and longevity, but it also has implications that he never dreamed of.

MSU scientists grew the moth mullein plants that came from the 90-year-old seeds and then studied them to determine if exposure to 90 years of natural soil radiation had any effect on their genetic structure and ability to reproduce.

Only seven of the original 20 seed-containing bottles that Beal buried remain in their hidden location on the MSU campus. The slumber of the seeds will remain undisturbed until 1980 — the 100th anniversary of Dr. Beal's experiment.

Beal used this pint bottle, and 19 others like it, to hold the buried seeds for his seed vitality experiment.

A collection of dried plant specimens arranged in systematic order and permanently preserved for reference and study is called an herbarium. Many years ago, however, such a collection was called a dried garden or a "hortussicus."

The Beal-Darlington Herbarium at Michigan State University is now 110 years old and contains more than 200,000 plant specimens, some of which were collected as early as 1815.

Plant specimens in the Herbarium were collected at locations all over the world. The best represented areas, however, are: Michigan; the southeastern United States; the western United States, including Alaska, and Mexico.

Dr. William J. Beal, professor of Botany at MSU from 1870 to 1910, was largely responsible for the founding and the initial growth of the Herbarium His natural curiosity, coupled with his research interests and farsightedness, led Beal to collect or purchase thousands of plant specimens for the Herbarium.

According to Dr. John H. Beaman, curator of the Beal-Darlington Herbarium, many of the plant specimens that Beal added to the Herbarium, particularly from 1890 to 1910, are "type specimens" — specimens that are the basis for the names of other plants of the same species throughout the world.

Many of these were received during the early expansion of the western United States when professional botanical collectors followed on the heels of settlers and other pioneers. The type specimens contained in the Herbarium collection now number about 1,300.

Current Research

According to Beaman, the research activities in the Herbarium generally reflect the interests of the staff and the other university faculty members associated with the Herbarium.

Beaman's major interest is in the taxonomy, ecology and distribution of alpine plants in Mexico and Guatemala. He also conducts other research projects dealing with the flora of North America.

Current research projects of other Herbarium staff members include: the study of secondary plant succession in tropical Asiatic forests, studies of desert plant communities, taxonomic studies of ferns; and research on sand dune plant communities.

The Beal-Darlington Herbarium participates in a program of specimen exchange with many other institutions throughout the world. "These exchanges enable us to continue adding many valuable specimens to the Herbarium which would otherwise be unavailable," Beaman says.

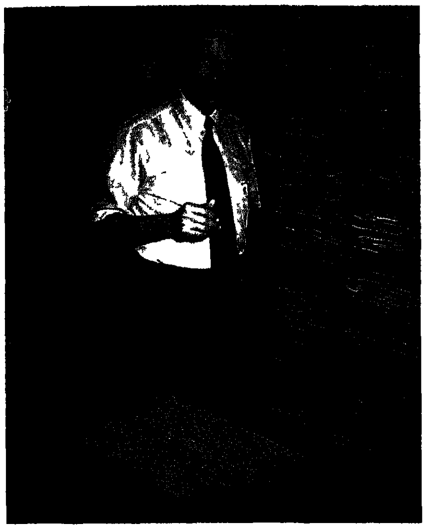
For special research projects, the Herbarium also borrows specimens from almost all other herbaria in the world. In return, it loans specimens to other qualified scientists upon request. Herbarium operations thus involve a very high level of international cooperation.

Herbarium Services

Besides providing facilities for botanical research and study, the Herbarium also provides other services to the university and the citizens of Michigan. The primary service provided by Herbarium staff members is the identification of unknown plants and plant material.

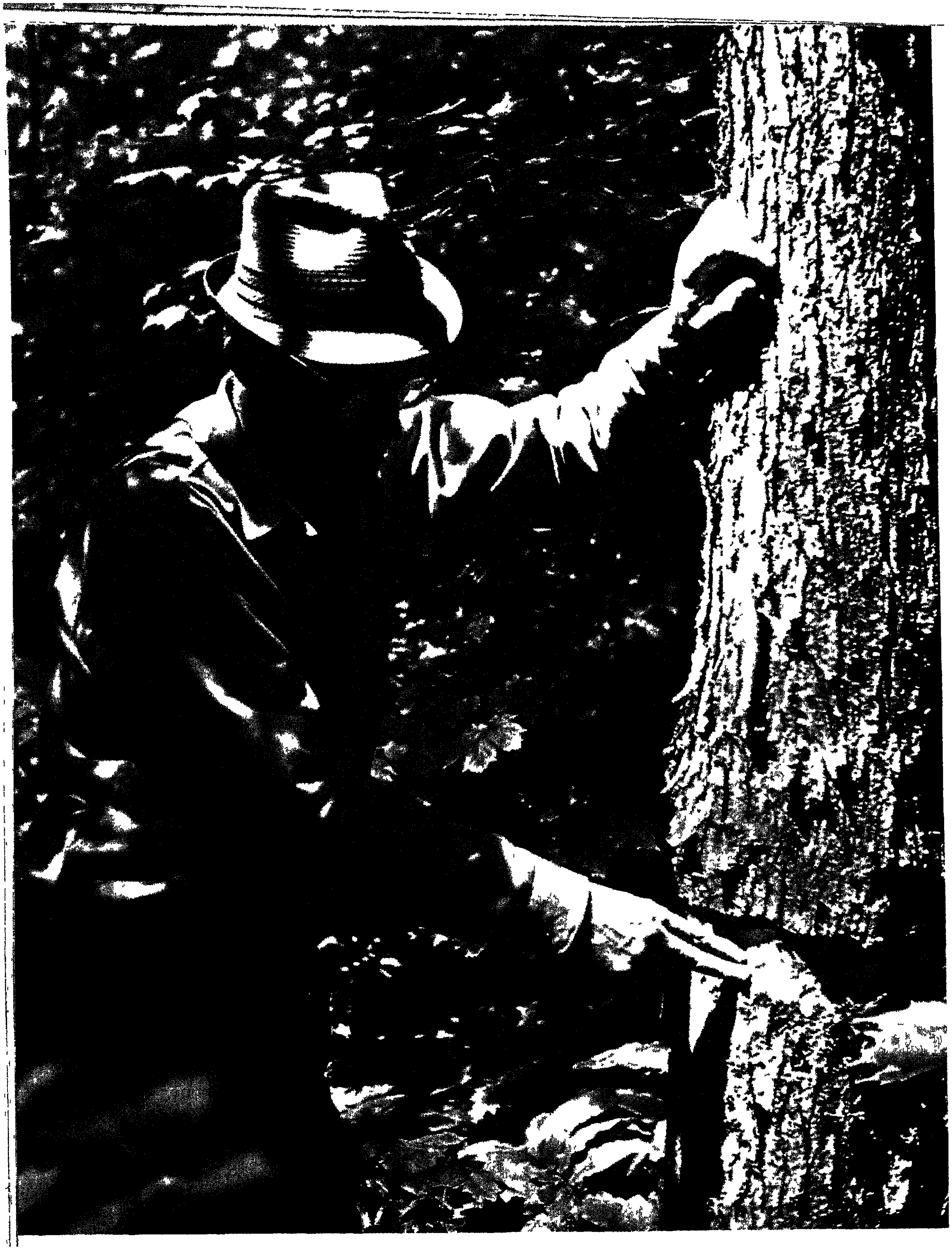
"The Herbarium is uniquely equipped for this purpose," said Beaman, "so it is important that this function is conscientiously performed in order to obtain the full value of the facility."

Beaman notes that specimens for identification usually come from either scientists in other MSU departments, or from the public. "The increasing public environmental awareness of the past three or four years has also had an effect on the Herbarium's service function. We are receiving an increasing number of requests for information about poisonous plants, edible plants, the distribution of plants, and similar questions," Beaman said.



Dr. John H. Beaman, curator of the Beal-Darlington Herbarium, and one of the type specimens purchased and mounted by Beal.

Plant specimens from the Beal-Darlington Herbarium are often loaned to research workers at other herbaria. Mrs. D. M. Snider remounts many of the specimens to provide adequate protection during transport through the mail.



Maurice W. Day, superintendent of MSU's Dunbar Forest Experiment Station in the Upper Peninsula, shares Beal's concern for good forest management

The [illegible]

Dr. William J. Beal was an amazing man For one thing, he labored happily for an annual salary of $1,800.

To be sure, $1,800 was not a bad salary back in 1883, especially when most of your colleagues were making the same amount and your employer kicked in a $3,400 home to boot. Such was life at Michigan Agricultural College 17 years before the turn of the century.

It apparently was a life that Beal liked very much. He was primarily interested in learning and teaching, and he had ample opportunity for both at MAC. It seems that finances were never a great personal consideration for him, and in 1889 he reported to the president of the college that, "To visit one or more states and lecture for pay has been declined for the past 3 years"

While he was best known as a botanist, Beal was also a forester and held the title of Professor Botany and Forestry from 1883 to 1896. Many campus attractions at MSU serve as living memorials to the work he did in those days before the institution attained university status.

The Campus Arboretum

Beal joined the staff of the Michigan Agricultural College in 1870. Five years later he established a campus arboretum by planting 150 species of trees and shrubs on a 2-acre site along Michigan Avenue west of the Abbot Street entrance to the college. The trees continued to grow and in 1894 he reported that "There are many interesting lessons to be gleaned from this plot of less than 2 acres, and the longer the trees stand the more valuable they will be for study by those interested in forestry."

The arboretum did not remain undisturbed, however. Sometime in the late 1890's a decision was made to use a portion of the site for a deer park. Beal's feelings toward this decision are clearly shown in his report to the president of the college in 1900· "As I expected, and said when this concession was made, every tree and shrub with a trunk 2 inches or less in diameter has been destroyed by the deer and elk, with the exception of a portion of the shagbark hickories. And in many instances larger trees have been destroyed or are on the way to destruction."

The deer and elk were eventually removed from the arboretum and the site was spared further destruction. It remains today as a place of lasting beauty and a tribute to Dr. Beal.

Reforesting Michigan

Beal recognized the need for more knowledge about the best methods and species to be used for reforestation In 1888 he wrote. "Michigan is yet a well timbered state, but the time is fast approaching when people now living will be inquiring as to what to plant and how to manage a tract of young trees for producing timber. It is a question whether considerable portions of our cheapest pine plains and stump lands had not better be replanted to forests (than used for farming)

He was not enamored with the lumbering practices of his time "Lumbering in our state has been conducted on a magnificent scale," he said, "but many of the processes are wasteful Rivers are dammed, lakes overflowed or drained, the forests deprived of young trees that ought to be left to produce more timber for the future

"Desolation follows the track of the lumberman who is after money and often does little to improve the country in any respect All of the beauty and most of the value is removed from the land where timber is removed. Stumps, rubbish, poor trees and small young trees are burned or charred and the ground left to grow up to briers, pin-cherries, poplars, birches, willows, scrub oaks and other worthless trees and plants.

"We can not help thinking that so far as his ability lies, the poor fellow who follows the lumberman in attempting to improve the land and make a comfortable home is a greater patriot, and deserving of more credit from the State than the man who merely cuts and removes the timber."

This attitude apparently brought Beal some criticism, because, as co-director of the State Forestry Commission, he was moved to preface his 1888 report to the State Board of Agriculture with the following:

> "From articles that have appeared in the public press, words that have been dropped in lectures and essays, and letters that have been written to the Commission, the feeling has grown upon the directors that in some quarters there is gross misapprehension of their views with regard to timber planting and removal, and they take the liberty of stating in this connection that they are not opposed to the removal of timber, they do not recommend that farmers should go to planting forests on good arable land; they do not believe that peril is imminent to Michigan as a result of the extensive elision of the forests.
>
> "On the contrary, they commend the practice of securing the best possible returns by cutting off the mature timber of our state, and have no sentiment to waste over the removal of the monarchs of the forest that are ready for harvest.

"They do deprecate wasteful methods of cutting, and feel most earnestly the desirability in Southern Michigan of planting out waste land, odd corners upon farms, and border of streams to rapidly growing trees that can be cared for at minimum expense, and will grow into valuable timber, largely while men are sleeping

"They do believe most emphatically in teaching children and young people a respect for growing trees, developing in them a love for the planting and growing of trees, and opening to them a knowledge of the influences of trees and forests upon the people and the modification as affected by the deforestation of a country They do feel earnestly the desirability of spreading among the people the most reliable information about tree planting, characteristics of the most desirable kinds to plant, economical management of farm woodlots, and the advantages that will accrue to the horticulturists of our state And lastly, they are not unmindful of the tendency, as a result of forest removal, to climatic conditions that characterize treeless regions to the west of us, which would in nowise be to our advantage."

The northern half of the Lower Peninsula was swept by the first wave of lumbering for white and red pine, the second wave of cutting, this time for hardwoods, was underway by the close of the 1880's.

Fire often followed the cutting, and the farmer who planted between the stumps discovered that much of the land was poor. A few years of farming removed the forest mold, leaving dry, barren sand where crops withered in the summer drought. Least promising of all were the jackpine plains around Grayling, where the sparse grass grew only in clumps, failing to form a carpet. Beal felt that if the right species of plants and trees could be found, the area could be planted and again become productive.

In 1888 he surveyed the pine plains in a canvas-topped wagon, crossing from Harrisville on the Lake Huron shore to Frankfort on Lake Michigan He was accompanied by four other botanists, two students, and reporters from the Detroit Tribune and Free Press. The newsmen wrote daily articles that appeared under such headlines as "Scientific Wanderers," "With Howling Wolves," and "A Barren Waste."

Beal established several small experimental plantings of trees and grasses that year near Grayling, Oscoda, Harrison, Baldwin, and Walton. Many of these were lost to heat, frost or drought. Only a few showed even the slightest promise But these test plots gave scientists some of their earliest information about what species would and would not grow on northern Michigan's cutover lands and hastened the day when more suitable species would be discovered.

Raising Trees for Lumber

By this time the light was beginning to show in what were once thought to be Michigan's unlimited pine forests. People of vision began to see that the lumber era was fast drawing to a close and new adjustments would have to be made with regard to man's treatment and use of the land

"It may seem strange to hear of raising trees for timber in Michigan," announced Beal, "but our people will soon begin to raise some kinds. The best trees to raise for timber seem to be white ash, hickory, black walnut, white pine, white oak, European larch and chestnut. An acre of timber raised, cultivated and properly cared for is of much more value than an acre of forest trees of the same species

"At the Agricultural College we have begun in a small way to raise some of our native trees, some foreign ones also, to see which will prove of most value for future generations to grow for profit, shelter and ornament"

Beal predicted that walnut would become one of the most valuable native Michigan trees and pointed out the need for studies aimed at producing these trees in farm woodlots MSU foresters are now evaluating the potential of growing black walnut trees in small clearings made in southern Michigan pine plantations.

Upon his recommendation, the Michigan State Board of Agriculture voted to cut no more of the woods at the Agricultural College, leaving approximately 150 acres that were in a more or less "directed" (managed) condition. The purpose was to make these acres timber models of their kind Different portions of the campus forests were managed in different ways to serve as object lessons.

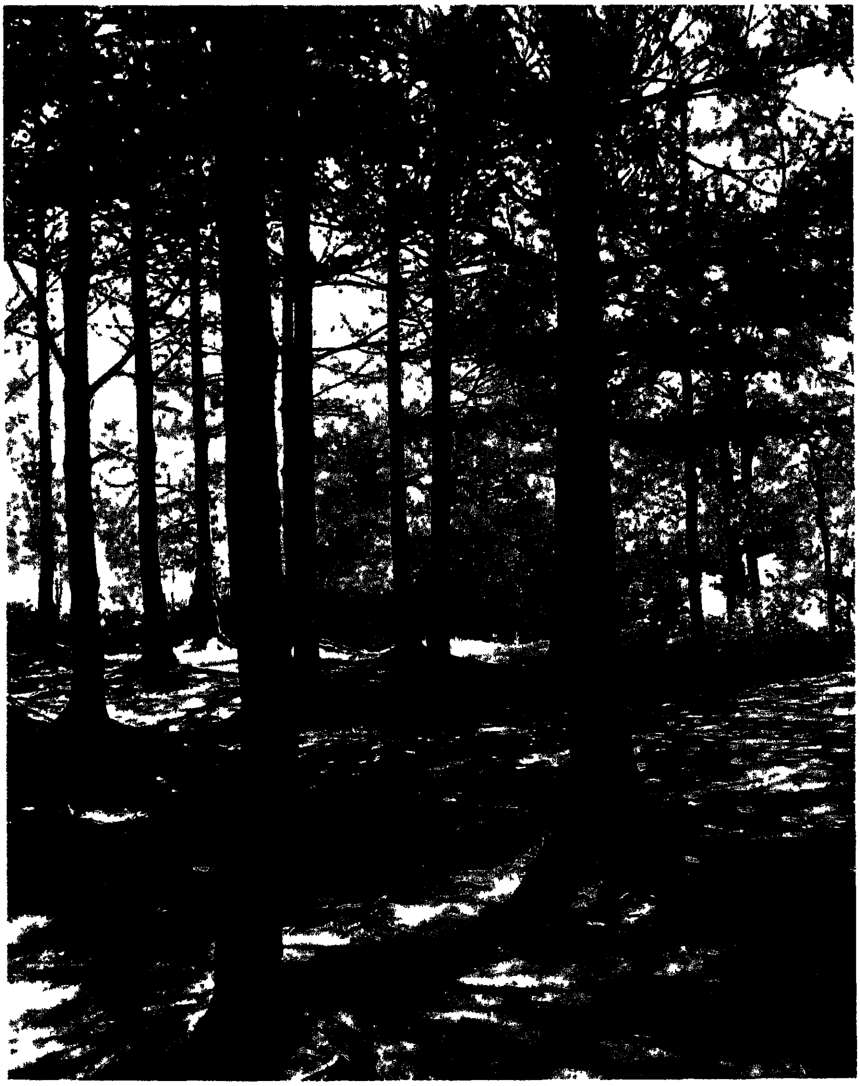
So Beal continued doing what he liked best — learning, teaching, lecturing, writing, exhorting — until he retired in 1910.

He once wrote that until a person begins to plant and cultivate trees, he can not realize how little anyone in this country really knows about the best species to select for growing and how to treat them from seeds to mature trees.

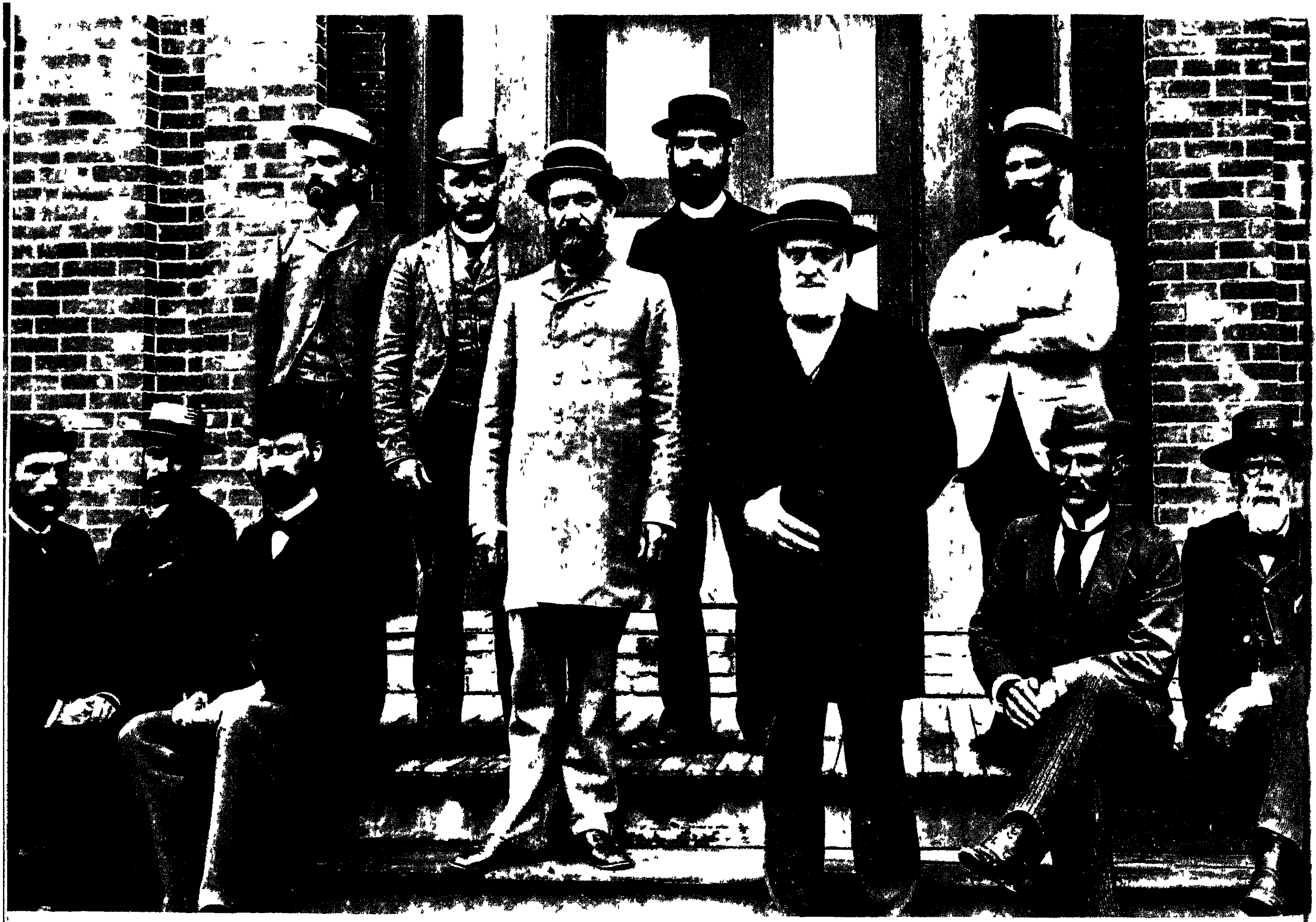
"For want of information, mistakes have been made," he said, "but even these mistakes often teach as much as the successes."

One of the old landmarks on the Michigan State University campus is the Beal Pinetum, a 2-acre plot of white pines established in 1896 and now stretching more than 80 feet toward the heavens. The stature of the pines is much like that of the man who planted them — tall, straight . . . and memorable.

The Beal Pinetum in the spring of 1973.



The Beal Pinetum in the 1910's.



The Michigan Agricultural College faculty of 1890-1891. Standing (left to right): E. Davenport, L. R. Taft, O. Clute, W. F. Durand, F. S. Kedzie and A. J Cook. Seated (left to right): H. G. Reynolds, R. C. Carpenter, E. P. Anderson, W. L. Simpson and W. J Beal.

Pioneering in Education

At the time of his retirement in 1910, Dr. W. J. Beal said, "I came here when it (MSU) was only 13 years old, having seen all her 6,000 or 7,000 students except perhaps 20."

When Beal first came to the Agricultural College of Michigan in 1870 he occupied not only a chair of science, but several of them. At various times he taught botany, horticulture, landscape gardening, forestry and even other subjects such as history.

Although Beal has many scientific discoveries and contributions to his credit it is, perhaps, his teaching that is of the greatest lasting value According to one of Beal's early biographers, a great part of this contribution is due to Beal's teaching methods.

For his time Beal was an educational radical. He championed the inductive, or laboratory, method of learning. His students learned by examining nature first, and secondarily from textbooks and formal lectures. "The longer I teach," said Beal, "the less I lecture my students, and the talks that are given are mostly regarding things which the students have previously examined."

To assist students in their learning efforts, Beal was one of the first professors in the United States to provide sophisticated microscopes for each student. An act that led to one of his most famous exhortations to his students — "Keep squintin'."

Beal voiced the basis for his then unusual teaching method as follows, "To be constantly giving information in science makes intellectual tramps, and not trained investigators." His objective was to turn students into independent and reliable observers and experimenters.

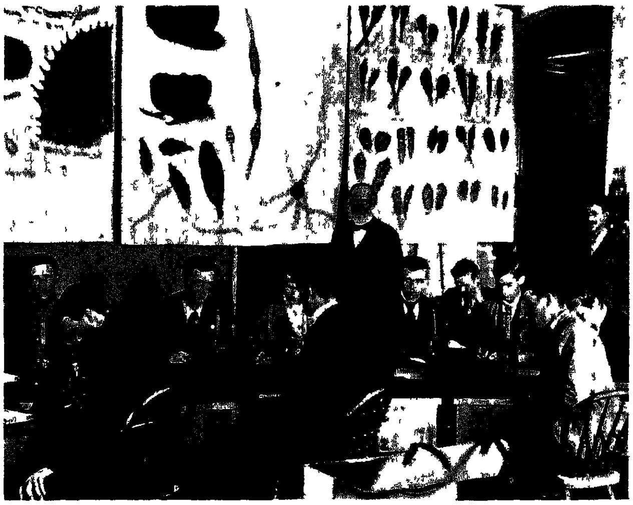
Students of Beal, and, in turn, their students, went on to perfect and develop the hybridization of corn — the crop that serves as the backbone of modern American agriculture. If this had been Beal's only contribution to scientific agriculture it would be sufficient to make him great.

Fortunately, however, Beal was free-giving of his plentiful ideas and talents. He was one of the first American educators to encourage the concept of environmental quality. Beal himself taught several courses in ecology, particularly to sophomore men and women.

He constantly encouraged his students to view botany as a science of both facts and variables, and cautioned them against making hasty conclusions. "Because a plant grows a certain way in Central Michigan, it is not always safe to conclude that it will do the same in New Jersey or California," he said.

After Beal had overcome early faculty and peer resistance to his unorthodox teaching methods, he succeeded in becoming internationally known for his teaching accomplishments In 1880 he gave a national lecture on his teaching methods called "The New Botany." It was later republished three times in pamphlet form, and in 1891 it was cited as one of five "best" internationally published books on teaching botany.

Beal's teaching influence continues long after his retirement in 1910 and death in 1924 Modern educational innovators at MSU follow in his footsteps. Beal's "look first and read later" concept of learning is still valid and many MSU students still profit from it. The actual process may have changed, but modern educational research proves Beal's ideas. Students are usually better teachers than the teachers.



Dr. W. J. Beal and a few of the more than 6,000 students who learned about botany in his laboratory.

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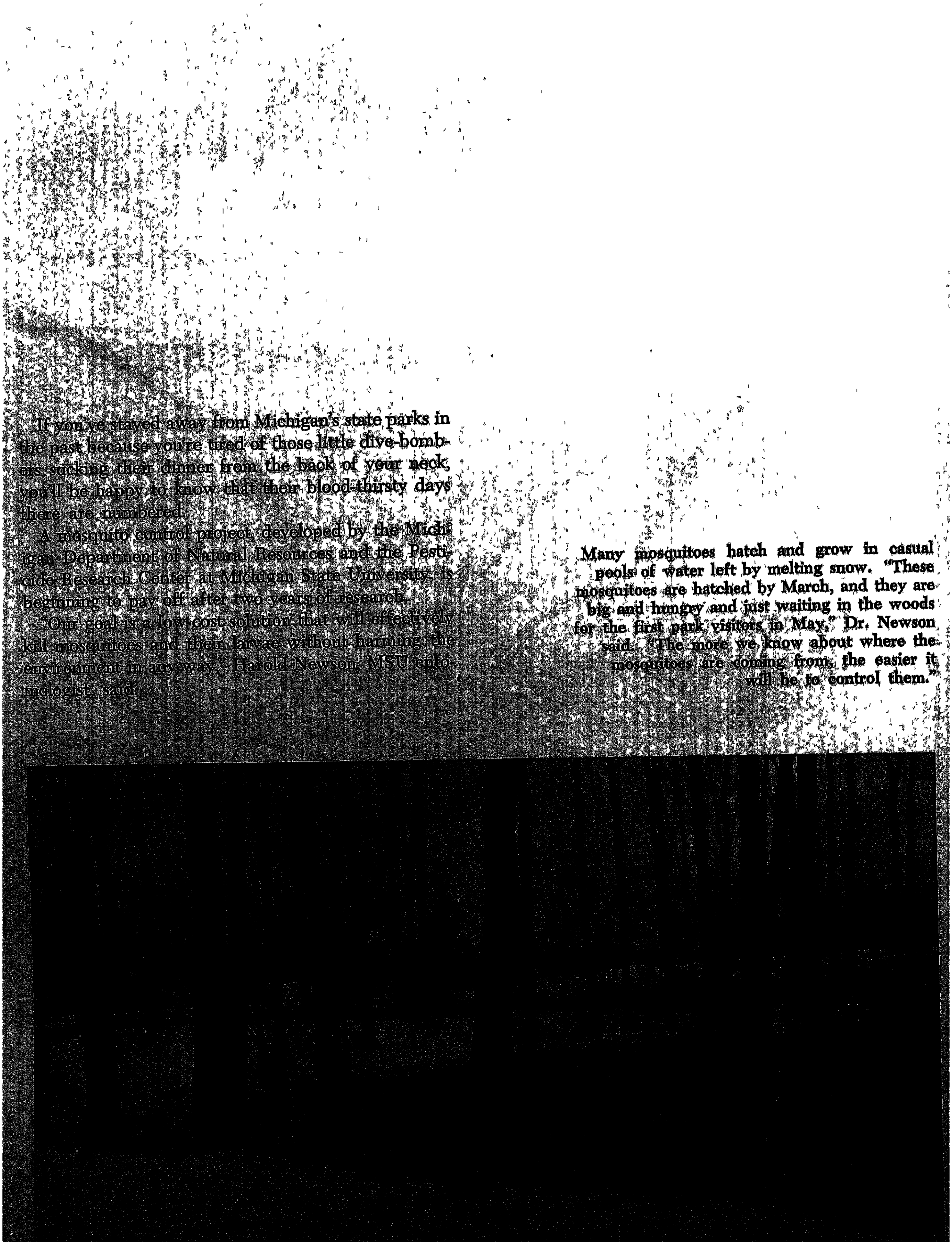
AGRICULTURAL EXPERIMENT STATION, EAST LANSING
SEPTEMBER 1973

25 CONTROL OF RECREATIONAL PESTS

If you've stayed away from Michigan's state parks in the past because you're tired of those little dive-bombers sucking their dinner from the back of your neck, you'll be happy to know that their blood-thirsty days there are numbered.

A mosquito control project, developed by the Michigan Department of Natural Resources and the Pesticide Research Center at Michigan State University, is beginning to pay off after two years of research.

"Our goal is a low-cost solution that will effectively kill mosquitoes and their larvae without harming the environment in any way," Harold Newson, MSU entomologist, said.



Many mosquitoes hatch and grow in casual pools of water left by melting snow. "These mosquitoes are hatched by March, and they are big and hungry and just waiting in the woods for the first park visitors in May," Dr. Newson said. "The more we know about where the mosquitoes are coming from, the easier it will be to control them."

basic plans

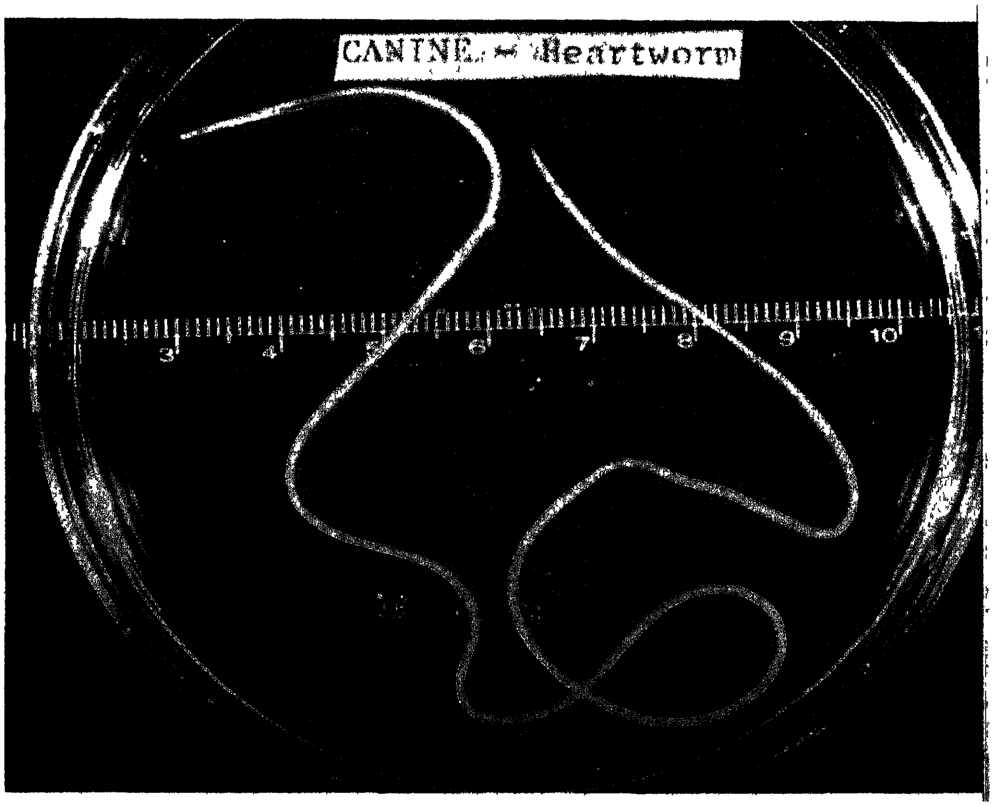
"In early March, 1971, we trained 'interpreters' in several state parks," Newson said. "These were people with biological backgrounds who interpreted the environment of the park and answered questions like: Which species of mosquito are in the park? Where are they coming from? What are their breeding habits — what time of year do they appear? And, which ones are most important in terms of biting humans or carrying diseases?"

Samples of immature mosquitoes from Michigan state parks were taken to MSU for analysis.

From the sample, it was determined that Yankee Springs State Park near Hastings in the southern part of the state, and North Higgins Lake State Park, in the north, are adequate representatives of their respective areas and concentrated testing of control methods would be initiated there.

"Chemical control at the larval and adult stages has been tested at Yankee Springs and North Higgins Lake with very satisfactory results," Newson said. "We now know enough to go into these parks with a limited control program this summer."

If the control programs in these parks are successful this summer, limited control programs will be offered to other state parks next year.



Some heartworms measure 12 inches. Depending on the dog — his size, health, susceptibility etc. — the first symptoms of circulatory problems may occur about six months after the mosquito has infected him.

mosquito bites do more than itch

The effort to control mosquitoes is not based solely on their role as pests.

Diseases carried by mosquitoes have recently become common in Michigan. Heartworm in dogs, a problem in the southern states for many years, is beginning to plague the dog population in Michigan.

Mosquitoes play a major role in the life cycle of the heartworm, transmitting the worms from one dog to another. If mosquitoes are not present the disease cannot be transmitted.

A bite from a heartworm-carrying mosquito can seriously affect the dog — for example:

> "Your dog has heartworm Mrs. Jones," the vet was saying, "that's the reason for his difficulty in breathing and his sluggishness. It's good you brought him in right away, because these symptoms will only worsen.

"Heartworms grow and breed in and around a dog's heart, eventually blocking the flow of blood and causing the dog to experience circulatory problems," Newson said.

"Preventive and curative drugs are available to check the disease," he said, "but an extensive mosquito control program would be far more effective."

they bug humans, too

California encephalitis, a mosquito-borne virus disease that affects humans, may become a problem in Michigan.

Symptoms of this virus often are not severe enough to require medical care — and since extensive laboratory testing is needed to confirm the presence of the disease, few cases have been reported or confirmed in Michigan.

The disease's symptoms, which are more severe in children, include headache, fever, restlessness, mental confusion, and drowsiness. In severe cases the victim may become stuporus, delirious, begin to twitch or go into a coma.

Disease symptoms may be eased under a doctor's care as the virus runs its course; however, eliminating the mosquito-carrier is a better solution.

relief on the way

"Mosquitoes come in a variety of species, each unique in its habits and tolerance to control methods," Newson said. "This is why extensive preliminary studies of an area are vital to the success of any control.

"Sewage lagoons, which have been added to some state parks, are excellent mosquito breeding grounds," he said. They are high in organic content—plant and animal by-products that mosquitoes feed on — but concentrated control methods can eliminate much of the problem.

One control substance already in use is Flit MLO, an oil which when spread on the surface of the water where the mosquito larvae are growing, attacks only the larvae and does not harm any other life, animal or marine, in the local environment.

In 48 hours there is no trace of the oil in the water.

Applied every eight days, Flit MLO effectively controls mosquitoes without resorting to sprays or other methods that could harm the environment or disturb park visitors.

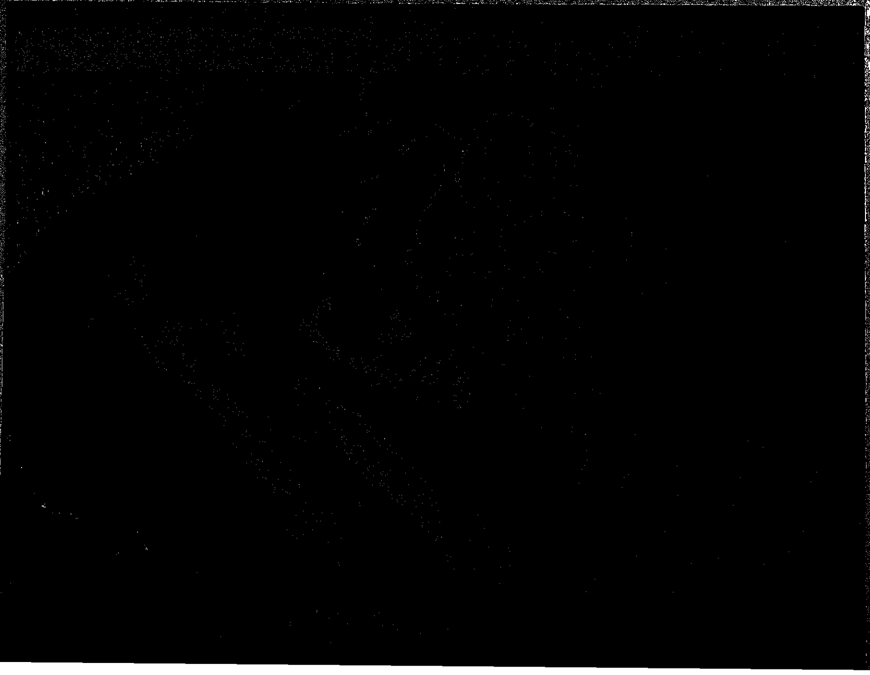
Tourism is one of the top three industries in the state. Twenty-three million people visit Michigan state parks each year. But at times these parks are emptied because the mosquitoes are so thick that people are almost inhaling them.

"With Michigan's tremendous recreational facilities, it's a shame that some of them go unused because pests are allowed to keep people away," Newson said. "When this control program is implemented, swatting mosquitoes and scratching their bites won't be a necessary evil of enjoying Michigan's outdoors."

future programs

"We are checking the progress of this mosquito control program closely with the hope that similar programs can be applied to other recreational pests in the future," Jon Roethele of the Michigan Department of Natural Resources said.

"If mosquito control in state parks is successful, there is no reason we can't go after the black fly, the deer fly or any other flying pest that affects the enjoyment of state parks," he said.



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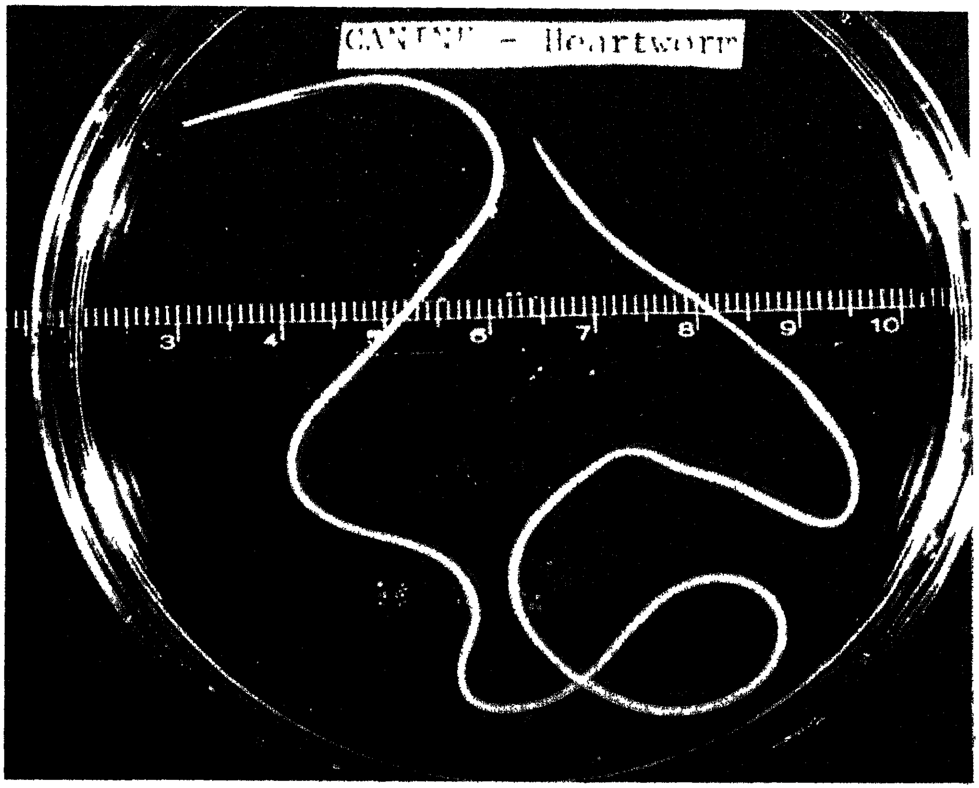

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a threat to recreational areas

The Gypsy moth, a pest that has caused widespread destruction of trees in the northeastern United States, appeared in Michigan for the third time in 1973.

"The moth defoliates trees and ruins the aesthetic and recreational values of forests, parks and wooded homesites," William Wallner, a Michigan State University entomologist, said. "A single two-inch caterpillar eats one square foot of leaf surface every 24 hours.

"The number of trees killed each year by the Gypsy moth is small compared to the number stripped of their foliage," he said, "but even a single defoliation can weaken the tree making it susceptible to other insects or diseases."

The Gypsy moth has been in this country since 1869, when specimens imported from Europe to breed with silkworms escaped during experiments in Massachusetts. Since then the pest has spread westward.

sexy traps

In an effort to study the Gypsy moth population and develop effective control methods, the Michigan and U.S. Departments of Agriculture, in cooperation with scientists at MSU, have set moth sex-lure traps in campgrounds throughout the state.

"You can catch more Gypsy moths with sex than by any other means," Wallner said.

A sex scent, an odor appealing to the erotic hunger of the male, is deposited in the traps, which are paper cups with small openings in each end. The cups are lined with a sticky substance that traps the moth much like fly paper grabs the fly.

The sex scent can lure a male from a mile-and-a-half away and is the key to the trap's success.

"The traps will not only tell us where the Gypsy moth population is, but also provide information that will help us keep the pest out of Michigan for as long as possible," Wallner said. "Hopefully, the data collected from the traps will give us the tools to control it properly when it arrives."

A Gypsy moth emerges from its cocoon which is resting on the side of a tent. The pest, which has terrorized forests in the Northeast for many years, is relentlessly moving west. Scientists feel it is inevitable the pest will become a permanent problem in Michigan.

hitchhiking pests

Only the male Gypsy moth can fly, but this isn't how the pest travels to Michigan.

"Gypsy moth eggs latch onto a recreational vehicle in the East and hitchhike into Michigan," Wallner said.

Gypsy moth quarantines have been established throughout most of New Hampshire, Vermont, Massachusetts, Rhode Island, New Jersey, Connecticut, Maine, New York and Pennsylvania These states restrict the movement of many items that might carry the pest to other parts of the country.

"The Michigan and U.S. Departments of Agriculture are doing all they can to prevent the Gypsy moth from gaining a foothold in the state, but it isn't easy," Wallner said. "The moths can hide in very small, concealed places, and the number of recreational vehicles entering Michigan is increasing."

Michigan State University entomologist Dr. William Wallner attaches a Gypsy moth trap to a hardwood in a Michigan forest. The trap, a paper cup lined with a sticky substance, uses a sex scent to lure the male moth. Traps help scientists find where the pest is and what methods could best control it.

"Michigan's large variety of hardwoods including oak, aspen (poplar), maple, beech and others are preferred hosts and very susceptible to the insect," Wallner said.

Traps set in early 1972 lured only one Gypsy moth each in Bay and Mecosta Counties, but a major infestation was found 10 miles southwest of Mt. Pleasant in Isabella County. In May 1973, about 8,000 to 10,000 acres in that area were sprayed with insecticides to combat the pest. A male trap survey of the lower peninsula this summer detected male moths in 14 more counties.

The red humped oakworm, a native of Michigan, defoliates trees like the Gypsy moth — but not to such a serious extent. The tree pictured here has been defoliated, and the worms are leaving in search of another victim.

"Effective control of Gypsy moth, or any other pest in Michigan, requires a great deal of time and research," Wallner said.

Other pests like the red humped oak worm, saddled prominent, forest tent caterpillar, cankerworms and others appear cyclicly in the state and information gathered on these native pests may help in the effort to control Gypsy moth.

Practical knowledge about control methods is very limited now, and Wallner cautions about the value of scientists' findings and control programs in the East to Michigan researchers.

"What may control Gypsy moth in an eastern forest will not necessarily work in Michigan's forests," he said. "Variations in weather conditions, predators and parasites and forest management may cause the differences in the effectiveness of control programs."

coordinating controls and management

Forest management — planting trees in one area instead of another, locating campgrounds and other high-use areas, and thinning and re-planting trees at various intervals—could help in the fight against forest pests.

Wallner offers an example of how forest management and pest control might work together to help alleviate an insect problem.

"Researchers in the East have noticed that Gypsy moths survive better on the edges of cleared or developed areas within forests than deep in the woods," he said. "The same may be true in Michigan, and not just for the Gypsy moth, but for other insects as well.

"To answer critical questions like this we need more time, money, research and cooperation," he said. "Control of pests like the Gypsy moth is crucial to the preservation of Michigan's forest resource, which is so important for timber and recreation."

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This is the 25th in a series of "Science in Action" publications aimed at relating the research developments in specific areas within Michigan State University's Agricultural Experiment Station.

This publication summarizes some of the latest research information on recreational pests.

We've also tried to show the areas of research to which we are committed and the prospective areas in which more research will be conducted.

For further information contact:

Dr. William E. Wallner, Department of Entomology.

Dr. Harold D. Newson, Department of Entomology.

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“The number of trees killed each year by the Gypsy moth is small compared to the number stripped of their foliage,” he said, “but even a single defoliation can weaken the tree making it susceptible to other insects or diseases.”

The Gypsy moth has been in this country since 1869, when specimens imported from Europe to breed with silkworms escaped during experiments in Massachusetts. Since then the pest has spread westward.

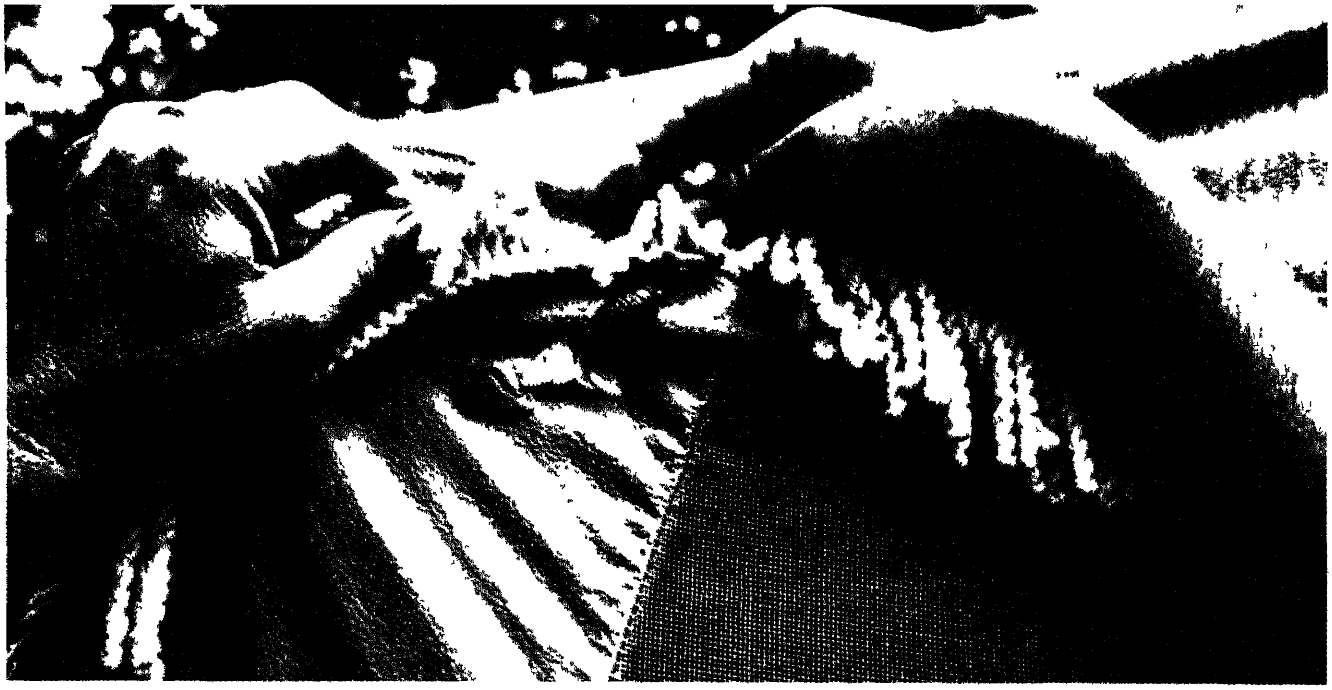
In an effort to study the Gypsy moth population and develop effective control methods, the Michigan and U.S. Departments of Agriculture, in cooperation with scientists at MSU, have set moth sex-lure traps in campgrounds throughout the state.

“You can catch more Gypsy moths with sex than by any other means,” Wallner said.

A sex scent, an odor appealing to the erotic hunger of the male, is deposited in the traps, which are paper cups with small openings in each end. The cups are lined with a sticky substance that traps the moth much like fly paper grabs the fly.

The sex scent can lure a male from a mile-and-a-half away and is the key to the trap’s success.

“The traps will not only tell us where the Gypsy moth population is, but also provide information that will help us keep the pest out of Michigan for as long as possible,” Wallner said. “Hopefully, the data collected from the traps will give us the tools to control it properly when it arrives.”



A Gypsy moth emerges from its cocoon which is resting on the side of a tent. The pest, which has terrorized forests in the Northeast for many years, is relentlessly moving west. Scientists feel it is inevitable the pest will become a permanent problem in Michigan.

hitchhiking pests

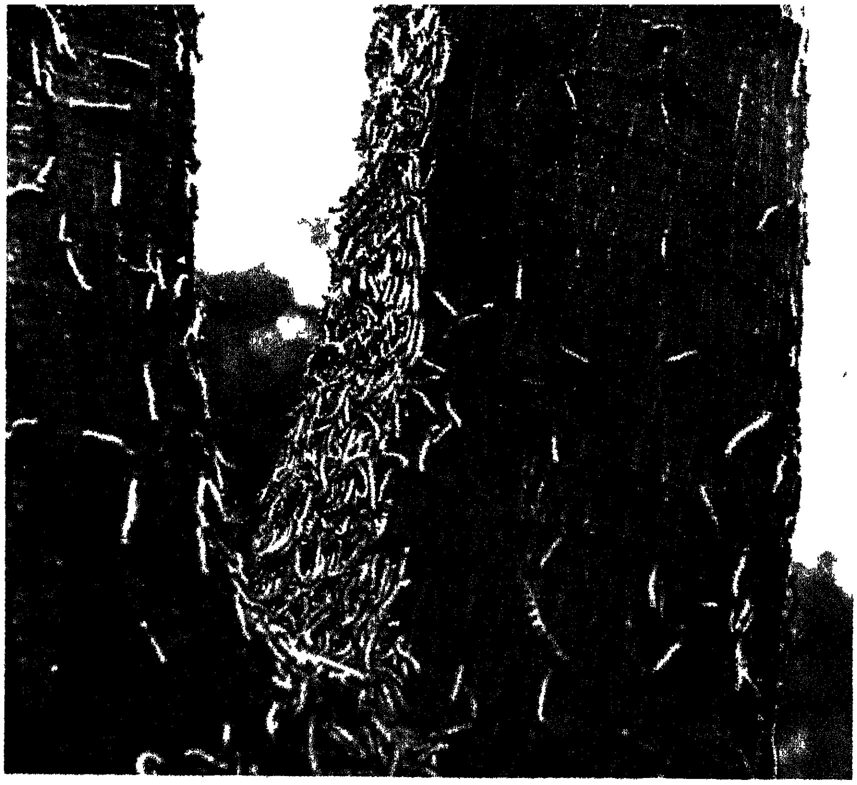
Only the male Gypsy moth can fly, but this isn't how the pest travels to Michigan

"Gypsy moth eggs latch onto a recreational vehicle in the East and hitchhike into Michigan," Wallner said.

Gypsy moth quarantines have been established throughout most of New Hampshire, Vermont, Massachusetts, Rhode Island, New Jersey, Connecticut, Maine, New York and Pennsylvania. These states restrict the movement of many items that might carry the pest to other parts of the country.

"The Michigan and U.S. Departments of Agriculture are doing all they can to prevent the Gypsy moth from gaining a foothold in the state, but it isn't easy," Wallner said. "The moths can hide in very small, concealed places, and the number of recreational vehicles entering Michigan is increasing."

Michigan State University entomologist Dr. William Wallner attaches a Gypsy moth trap to a hardwood in a Michigan forest. The trap, a paper cup lined with a sticky substance, uses a sex scent to lure the male moth. Traps help scientists find where the pest is and what methods could best control it.



The red humped oakworm, a native of Michigan, defoliates trees like the Gypsy moth — but not to such a serious extent. The tree pictured here has been defoliated, and the worms are leaving in search of another victim.

"Michigan's large variety of hardwoods including oak, aspen (poplar), maple, beech and others are preferred hosts and very susceptible to the insect," Wallner said.

Traps set in early 1972 lured only one Gypsy moth each in Bay and Mecosta Counties, but a major infestation was found 10 miles southwest of Mt. Pleasant in Isabella County. In May 1973, about 8,000 to 10,000 acres in that area were sprayed with insecticides to combat the pest. A male trap survey of the lower peninsula this summer detected male moths in 14 more counties

"Effective control of Gypsy moth, or any other pest in Michigan, requires a great deal of time and research," Wallner said.

Other pests like the red humped oak worm, saddled prominent, forest tent caterpillar, cankerworms and others appear cyclicly in the state and information gathered on these native pests may help in the effort to control Gypsy moth.

Practical knowledge about control methods is very limited now, and Wallner cautions about the value of scientists' findings and control programs in the East to Michigan researchers.

"What may control Gypsy moth in an eastern forest will not necessarily work in Michigan's forests," he said. "Variations in weather conditions, predators and parasites and forest management may cause the differences in the effectiveness of control programs."

coordinating controls and management

Forest management — planting trees in one area instead of another, locating campgrounds and other high-use areas, and thinning and re-planting trees at various intervals—could help in the fight against forest pests.

Wallner offers an example of how forest management and pest control might work together to help alleviate an insect problem.

"Researchers in the East have noticed that Gypsy moths survive better on the edges of cleared or developed areas within forests than deep in the woods," he said. "The same may be true in Michigan, and not just for the Gypsy moth, but for other insects as well.

"To answer critical questions like this we need more time, money, research and cooperation," he said. "Control of pests like the Gypsy moth is crucial to the preservation of Michigan's forest resource, which is so important for timber and recreation."

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This is the 25th in a series of "Science in Action" publications aimed at relating the research developments in specific areas within Michigan State University's Agricultural Experiment Station.

This publication summarizes some of the latest research information on recreational pests.

We've also tried to show the areas of research to which we are committed and the prospective areas in which more research will be conducted.

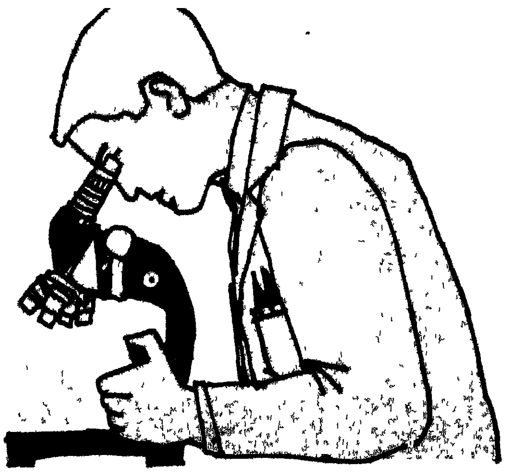
For further information contact:

Dr. William E. Wallner, Department of Entomology.

Dr. Harold D. Newson, Department of Entomology.

SCIENCE ACTION

FROM THE MICHIGAN STATE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION, EAST LANSING
FEBRUARY 1974



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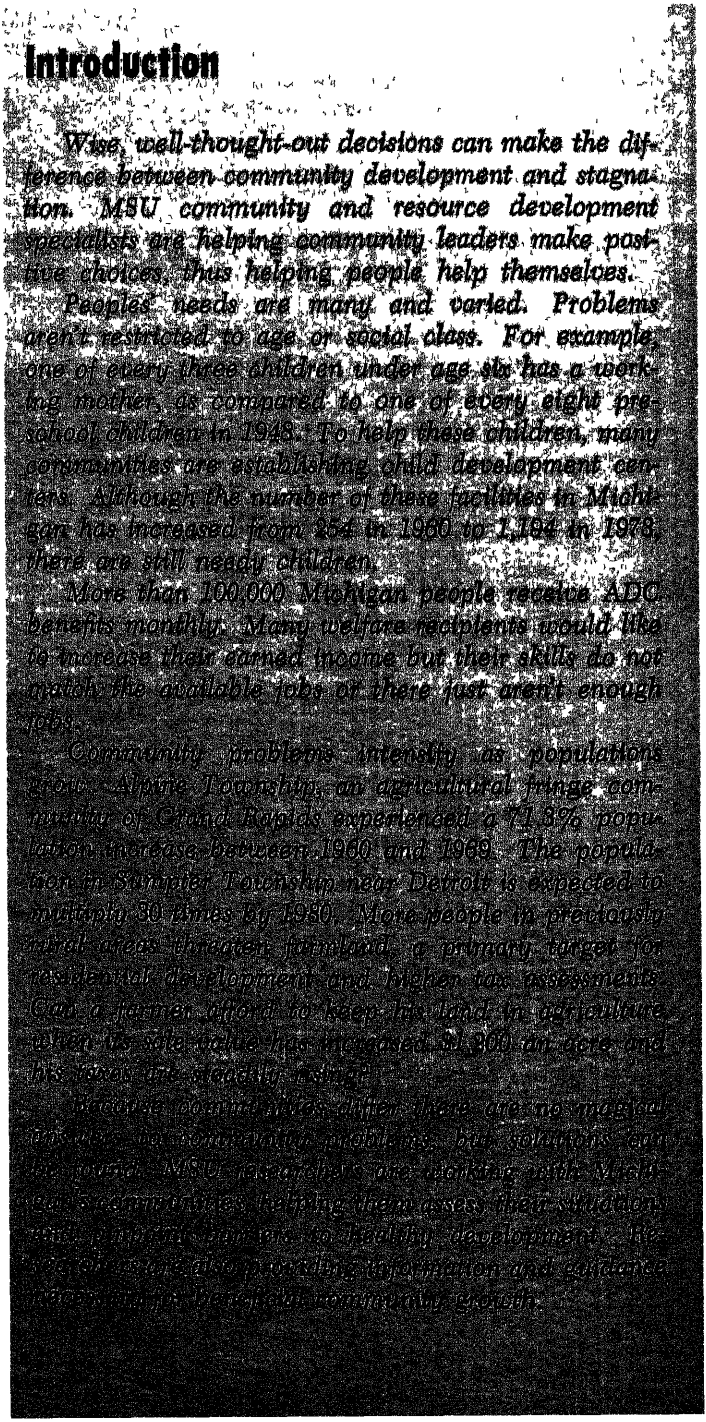
FOCUS ON COMMUNITY DEVELOPMENT

INST. LI



Introduction

Wise, well-thought-out decisions can make the difference between community development and stagnation. MSU community and resource development specialists are helping community leaders make positive choices, thus helping people help themselves.

Peoples' needs are many and varied. Problems aren't restricted to age or social class. For example, one of every three children under age six has a working mother, as compared to one of every eight preschool children in 1948. To help these children, many communities are establishing child development centers. Although the number of these facilities in Michigan has increased from 254 in 1960 to 1,194 in 1973, there are still needy children.

More than 100,000 Michigan people receive ADC benefits monthly. Many welfare recipients would like to increase their earned income but their skills do not match the available jobs or there just aren't enough jobs.

Community problems intensify as populations grow. Alpine Township, an agricultural fringe community of Grand Rapids experienced a 71.3% population increase between 1960 and 1969. The population in Sumpter Township near Detroit is expected to multiply 30 times by 1980. More people in previously rural areas threaten farmland, a primary target for residential development and higher tax assessments. Can a farmer afford to keep his land in agriculture when its sale value has increased $1,200 an acre and his taxes are steadily rising?

Because communities differ there are no magical answers to community problems, but solutions can be found. MSU researchers are working with Michigan's communities helping them assess their situations and pinpoint barriers to healthy development. Researchers are also providing information and guidance necessary for beneficial community growth.

Is There A Way Out?

MSU agricultural economists are helping welfare recipients loosen the jaws of the ADC trap.

The trap, inadequate transportation and day care facilities compounded by a lack of jobs, makes it impossible for many parents to support their families without public assistance.

"Many welfare recipients are ready and willing to work in self-supporting jobs," says Allan Schmid, MSU agricultural economist. "But there is a shortage of steady jobs that pay enough to support a family."

Schmid draws his conclusions from an Allegan County welfare study he directed in 1972. The study showed that rural welfare recipients are more employment-ready and have more work experience than their urban counterparts in Michigan.

Researchers suggested public service employment programs be started to provide work-training experience.

"Training the unskilled to fill available jobs and notifying the unemployed when job vacancies arise would help loosen the grip of the ADC trap, too," Schmid claims.

Lack of transportation compounds the job shortage problem. The Allegan County survey revealed that 35% of welfare families had no car, making a distant journey to and from work impossible.

"Also," says Schmid, "young children inhibit outside employment because an adult must remain home to care for them."

With these problems in mind, the agricultural economists proposed that day care facilities be improved and public transportation to and from work be provided.

Research results revealed that parents were bound to the public welfare system by the nature of eligibility rules. For instance, if a father works over 100 hours a month, his family becomes ineligible for ADC-U benefits.

"After taxes, he doesn't make enough additional income to give him work incentive," explains Schmid.

Researchers proposed eliminating the 100-hour rule and initiating tax reform to lessen the handicaps of people struggling their way out of the ADC trap.

MICHIGAN STATE researchers are helping communities help children. Community and child development specialists assisted Lake County Citizens in organizing a local child development center. "The focus of the Lake County project was on the community's role in meeting the needs of children," says Gaye Benson, MSU community development specialist. "Citizen participation can make or break a new child development facility."

The importance of gaining community support while the center is still "on paper" is discussed in detail in a soon-to-be-published manual designed to help other communities establish child care facilities. In Lake County, researchers visited local organizations — PTA's, Kiwanis clubs, garden clubs — to explain the need for organized child care.

"More than 40% of Michigan's preschool children could benefit from child care facilities," claims Benson. "These are children with limited educational backgrounds or working parents. Although 132,000 of them live in poverty, many come from middle and upper middle class families."

Researchers found that adequate initial funding should also be secured early in the planning stages and they learned the importance of sound administrative policies. The manual, therefore, emphasizes that administrators should know how to work with adults just as teachers should know how to work with children, a criterion frequently not considered in choosing administrative personnel.

Child development center staff and parents discuss the center's programs and activities. Good interpersonal relationships are as important between adults as between adults and children.

Below: Special attention given youngsters at child development facilities helps them get a fair start in life. Right: Learning to play together as children teaches people to work and live together as adults.

THE LAKE COUNTY child development center is one of nearly 1,000 centers established in Michigan in the last 18 years. "Problems encountered in Lake County are similar to those encountered by many new centers," explains Jeanne Brown, MSU child development specialist and coordinator of the Lake County project, "but each community situation differs." For this reason, the manual does not give people simple steps to follow but explains the implications of different community choices.

"We tell people what to consider and how to consider it," says Benson. "The final decisions are up to individual communities in their individual situations."

Children improvise a rhythm band. Day care teachers encourage children to develop their imagination and inventiveness.

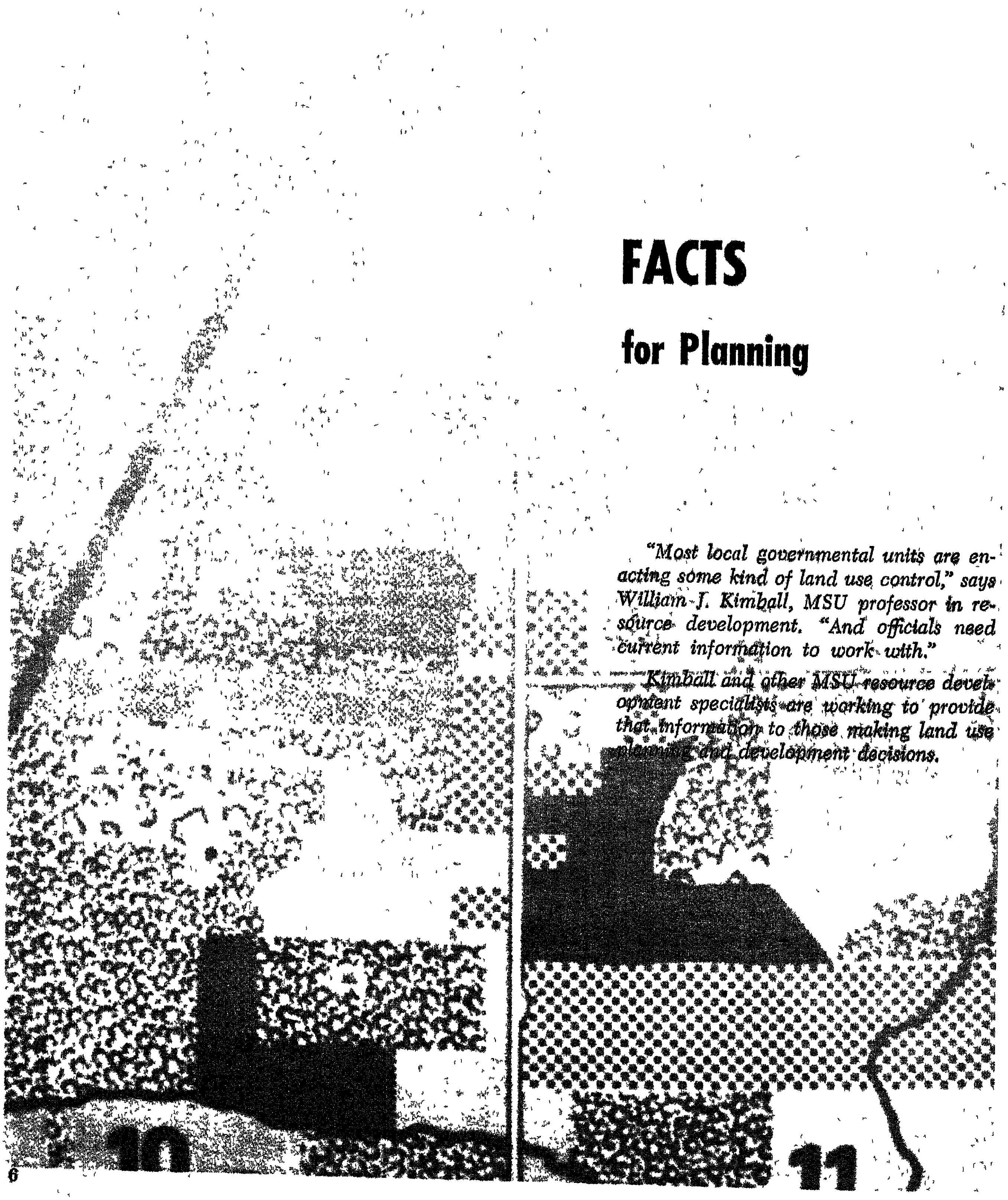
Photos courtesy of Institute for Family and Child Study, MSU.

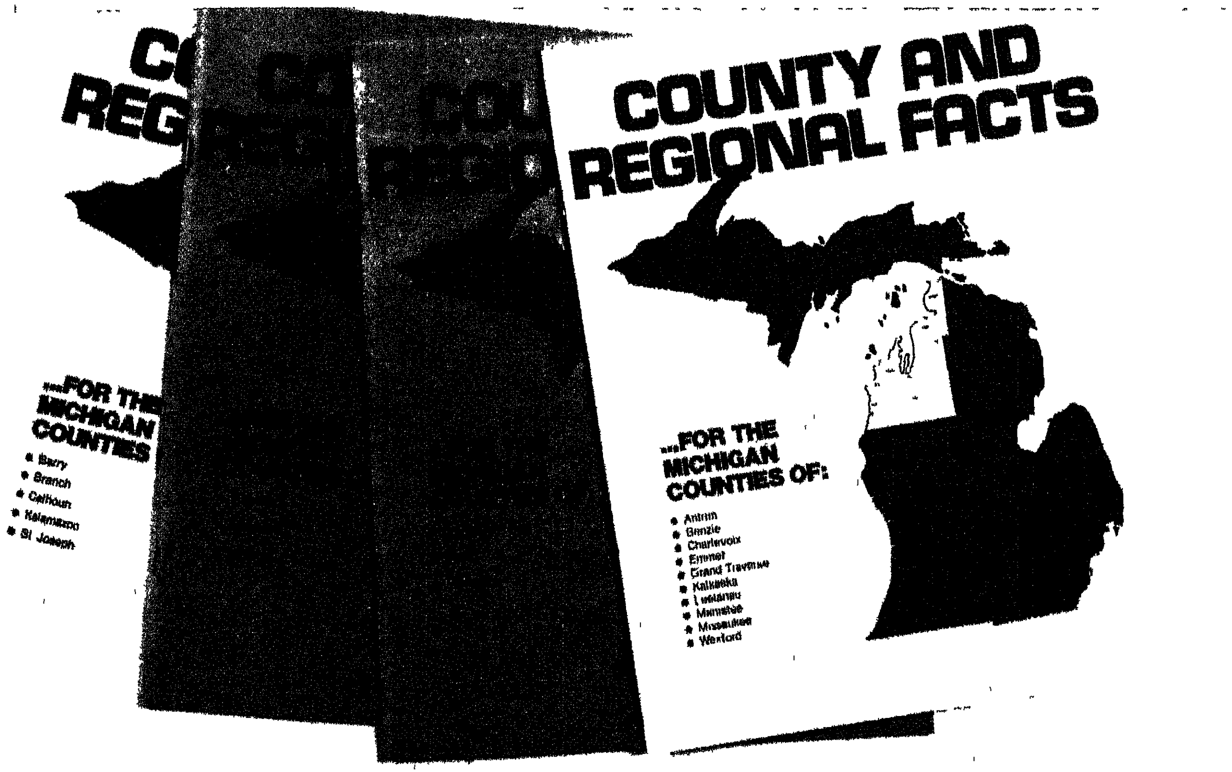
FACTS

for Planning

"Most local governmental units are enacting some kind of land use control," says William J. Kimball, MSU professor in resource development. "And officials need current information to work with."

Kimball and other MSU resource development specialists are working to provide that information to those making land use planning and development decisions.





Michigan County and Regional Fact Books provide up-to-date information for community planners. Listing population, economic and geographic characteristics, the fact books provide a basis for comparing all counties and regions in Michigan.

Booking the Facts

Information on everything — from the number of women in Ogemaw County to the number of lakes in Ingham County — can be found in the 13 County and Regional Fact Books published in 1972 by Michigan State University and the State of Michigan.

Filled with up-to-date statistics, the Fact Books are Michigan's first attempt to assemble data with which all counties and regions can be compared.

A county commissioner commented, "I've been telling my associates for years that our welfare expenditures are way out of line. Now, with Michigan Fact Books, I can prove it."

This commissioner could compare his welfare problems with those of Clinton County, for example. Clinton County spends $8.40 per person on its welfare program. In addition, more than 5% of the county's 11,772 resident families are below poverty level, 5% of housing is substandard, and 9.9% of all households lack some or all plumbing facilities.

The fact books are also handy tools for land use planning. Information on farms and manufacturing establishments and their current values is helpful for figuring tax revenues. The books also indicate the number of acres taken up by agricultural, recreational and urban uses.

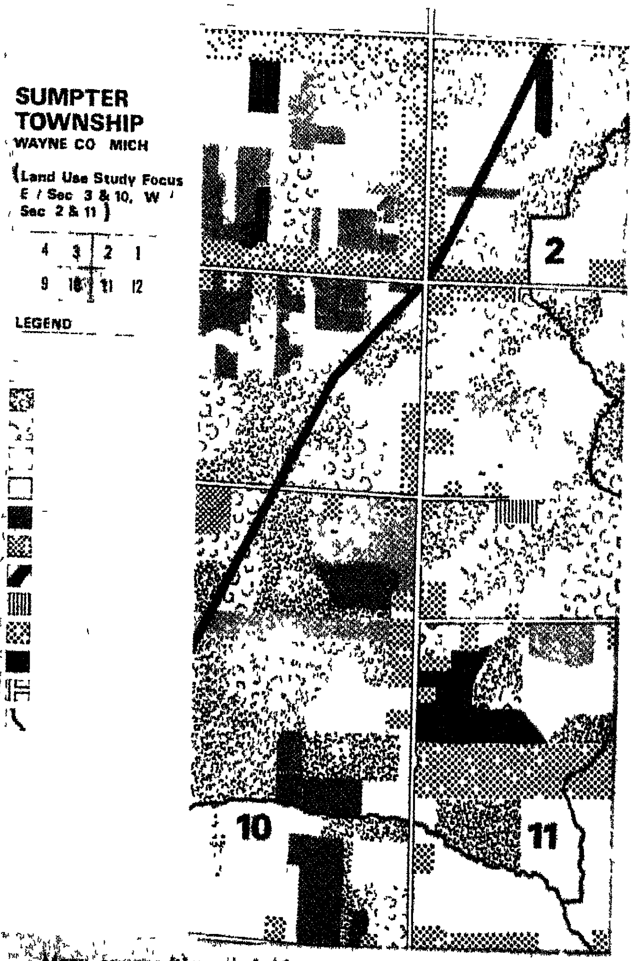
"With this extensive inventory of current land resources," says Kimball, "decisionmakers can better plan for wise land use and development."

Zeroing in on Zoning

Planning and zoning efforts have mushroomed since 1966. Township planning organizations increased from 113 in 1966 to 315 in 1972. The number of county planning boards has nearly doubled in that 6-year span. In 1968, regional planning districts were set up.

To make available current information on planning and zoning activity in Michigan, MSU resource development specialists and State Planning Division personnel began an extensive inventory of all planning and zoning activities in the state in 1972.

"The published results make a convenient reference book," says Charles Kaufman, district extension leader in resource development. "A great variety of agencies have taken advantage of it."



Many communities use land use maps to study their current resources. Those governmental units who have done mapping studies are listed in the Michigan Planning and Zoning Survey.

State police use the Planning and Zoning Survey to keep track of local laws such as noise and nuisance ordinances, and the highway department uses it to check on the development plans of a community before plotting new roads through it.

"Local, regional and state planning officials can draw on the plans of others in making up their own land use planning programs," explains Kaufman.

Results of the Planning and Zoning Survey were published for each of Michigan's 13 regional planning districts. Each regional publication lists planning and zoning boards on township, municipal, county and regional levels and the kind of technical assistance they seek.

Townships most frequently employed private consultants while cities and counties, with larger budgets, usually employ their own planning staffs. Townships often seek advice from County, Cooperative Extension Service, and Soil Conservation Service planning personnel.

The surveys also indicated the planning and zoning activities that have taken place at all levels of government throughout each region. Most frequent are future land use and zoning studies, population inventories, and land use mapping.

Survey data were collected through questionnaires sent to county planners or to Cooperative Extension Directors in counties with no formal planning staff. Compiled survey results were distributed to governmental and planning units, libraries and selected university departments.

Citizen Survey

To shed light on citizens' attitudes toward land use planning and zoning, MSU resource development specialists in 1972 conducted a Land Use Goal Study in Ionia County.

"Planning commissions often feel they know what their constituents think about planning and zoning issues when, in fact, they don't," explains William Kimball.

Ionia County officials had held back on subdivision and mobile home controls because they felt rural residents were opposed to them. The study, however, pointed out that rural residents favor these controls as much as urban residents do. This was good news to the planning commission who began working on new land use programs.

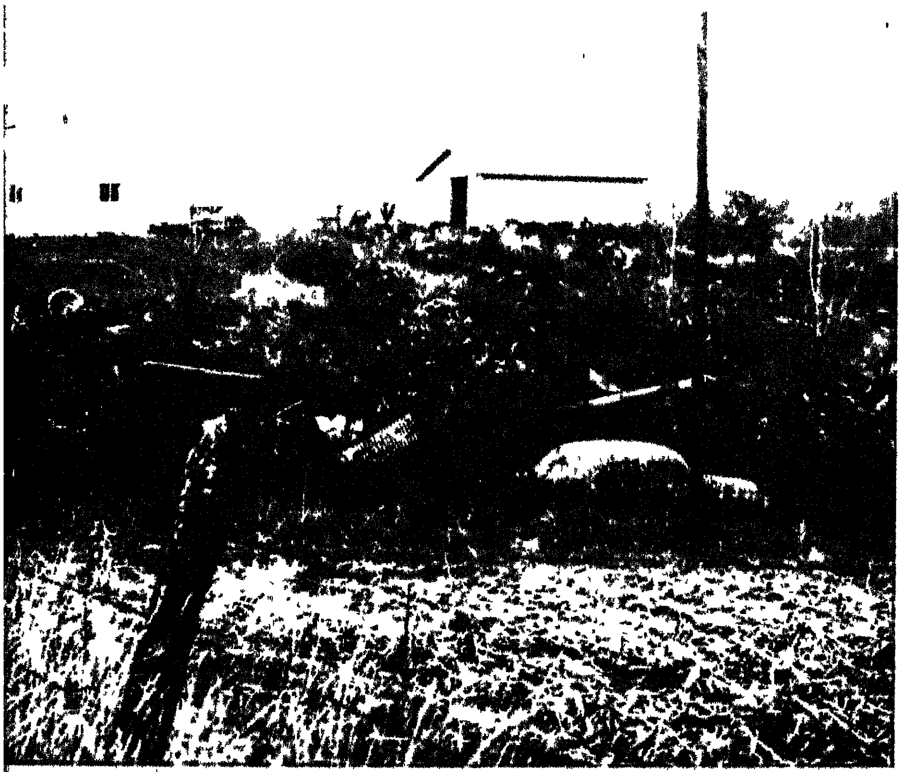
Researchers sent questionnaires to 1,836 Ionia County residents, and interviewed those who did not return their questionnaires. In addition, Allan Schmid, MSU agricultural economist and resource development specialist, and Kimball conducted extensive personal interviews in a smaller region of the county.

Three-fourths of the respondents, when asked about agricultural land retention, felt that farmland should be protected against residential, commercial or industrial encroachment.

Most Ionia County residents questioned desired additional housing, especially single family units. Nearly half preferred these residences be placed in subdivisions adjacent to or within villages and cities.

Respondents also favored additional development of light manufacturing in the county and control of unique lands for recreational use.

The Ionia County citizen survey is being expanded to cover the Thumb counties of Huron, Sanilac, and Tuscola.



Above: Poor planning and zoning practices have caused land use conflicts in agricultural and residential areas. No one wants a dump next door.

Below: Any home builder finding his lot flooded during the rainy season would surely opt for land use controls to keep swamp areas non-residential. While wet places are not ideal for human nesting grounds, they're great for birds and small wild life.

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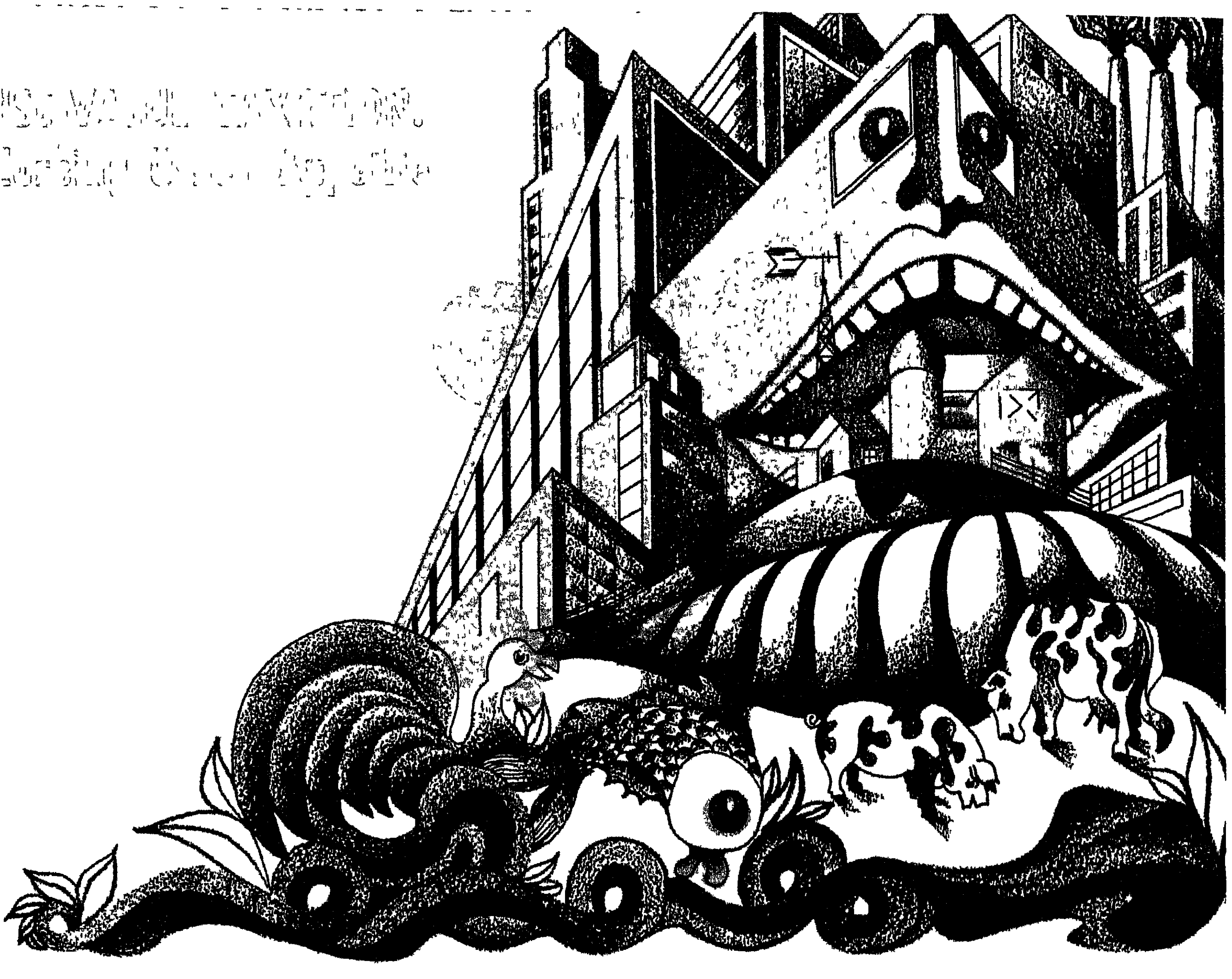


Michigan's hungry cities are eating valuable cropland. Between 1920 and 1964, they nibbled away more than a million acres of prime farmland in the lower Peninsula. In the past 10 years they have consumed surrounding open spaces at an even faster rate. Michigan State University resource development specialists have been studying preferential taxation, one method of protecting needed agricultural lands and controlling the appetite of sprawling metropolises.

"Rising taxes are a serious problem for farmers wishing to keep their land in agriculture," says Raleigh Barlowe, MSU professor in resource development and head of the taxation studies. "When urbanites move to the outskirts of a city, they demand services—sewage, water, fire protection—that farmers never felt the need for. The result is skyrocketing taxes for agricultural as well as residential property."

Since farm income per acre is relatively low, many farmers are forced to sell their property for higher paying, more urbanized uses like apartment complexes, subdivisions and shopping centers.

The MSU taxation study covered five predominantly agricultural townships in Kent County near Grand Rapids and five in Macomb County north of Detroit. Because these townships surround Michigan's largest metropolitan areas, population has increased well beyond the state average rate of 13.4%. The increase in Alpine Township, Kent County, was 71.3%. The average increase for Macomb County was 54%.

Computer programs were used to simulate the redistribution of property tax burdens that would have resulted under different preferential or use-value taxation systems had they been used between 1960 and 1970.

One system tested was *simple use-value assessment* whereby land is assessed according to its current use. Farmland with a relatively low income per acre would then be assessed much lower than business with high income per acre and residential property whose owners demand the increase in consumer services.

Deferred taxation was also tested. Under this system agricultural and current market values of farmland are assessed each year. If farmers keep their property in agriculture, they pay taxes on the lower value. If they convert it to higher income uses before a specified time, they must pay the higher tax rate. In addition, they are penalized the amount they had already saved in lower tax rates.

Three- and five-year time or rollback periods were used in this study.

Data for the study were collected from township property tax rolls, county treasury and equalization departments, and the Michigan Department of Treasury.

Researchers found that tax rates decreased most for farmers and least for rural residents under simple use-value assessment *if* farmer participation was limited to about 20%. With this limitation, revenue lost to local government could be recovered from homeowners without severely increasing their taxes.

"However, rollback or deferred taxes provide more incentive for farmers to keep their land in agriculture because they will be penalized if they convert before the 3- or 5-year rollback period has ended," says Barlowe.

The lowest tax increase for non-participating farmers and non-farmers occurred under a 5-year rollback plan Under this taxation system, a large amount of "penalty" revenue covers costs which residents would normally pay.

In the 10 counties studied, it appeared the lowest taxes would occur when participation in a use-value assessment program was limited.

Dr Barlowe explains, "Setting high standards for participants could eliminate smaller, less serious 'non-professional' farmers and give tax breaks to those who seriously want to stay in agriculture" These requirements may include high productivity ratings, acreage limitations and zoning requirements.

The success of use-value taxation in keeping open space and agricultural land was limited in all the simulation studies. Tax savings to farmers are low compared to profits from agricultural land sales. For example, tax savings on a 40-acre farm in Alpine Township under a use-value system would have ranged from $819 to $1,619 in the 10-year study period. In the same period, the market value of this property may have increased by more than $50 thousand. Rapid increase may, however, give the farmer further incentive to hang on to his land while its market value skyrockets.

The Kent and Macomb county tax studies pointed out there is no magic taxation formula to curb urban appetite for agricultural land. Thus cities may continue to lure corn fields away from agriculture. Recognizing the value of agricultural land, preferential assessment measures may help keep hungry metropolises at bay.

Michigan's surburbia comes to the farm Preferential taxation measures may help farmers decide whether corn fields will be planted or paved in the future.

MSU remote sensing specialists are using space photography to solve earthbound planning problems. Pictures snapped by NASA satellites and high-altitude RB-57F aircraft have been instrumental in laying out Michigan's highways, monitoring its wildlife areas, and planning use of open space land.

"Remote sensing literally means getting information by any means but touch," explains Stephen Schar, coordinator of the MSU remote sensing project. "At MSU we primarily use light waves to study land use and land formations."

An extension of photography, satellite imagery is the most complex type of remote sensing done at MSU. Four different kinds of light varying from green to near infrared may be shot from the satellite as it sweeps over Michigan. Each different wave length highlights a specific kind of land formation, area of vegetation, or body of water. Red light, for example, spotlights agricultural and forest land, while infrared waves accent swamps, lakes and rivers. This "highlight" information is transferred numerically to computer tapes, then converted to map-like photos in NASA and ERIM (Environmental Research Institute of Michigan) laboratories.

These maps look like computer print-outs with dashes, x's, and 0's illustrating the various highlighted areas, or like newspaper photos with varying shades of grey and black.

Similar maps are taken by cameras in RB-57F aircraft. Because specialists who interpret remote sensing maps must be familiar with the study area, photos are also taken by ground crews.

"Without these 'ground truth' studies, accurate interpretation would be impossible," says Schar. "A septic tank drainage field might look the same as a well-fertilized or sprinkled lawn. Only the denser vegetation shows up; and the reason for it is not apparent from the aerial photos alone."

MSU remote sensing specialists have helped more than 25 governmental and business agencies with planning and resource development decisions. The Michigan Department of Highways used RB-57F aircraft photos to assess the environmental impact of M-14, M-59, US-31, and I-69 highways. Remote sensing maps have also identified wetlands, valuable timber resources and recreational lands so that highway planners may avoid these areas when locating new roads.

Remote sensing information comes in two forms: digital maps which look like computer print-outs (opposite page) and analogues, similar to newspaper photographs (right). Both these maps show part of the Pointe Mouillee Wildfowl Feed Area.

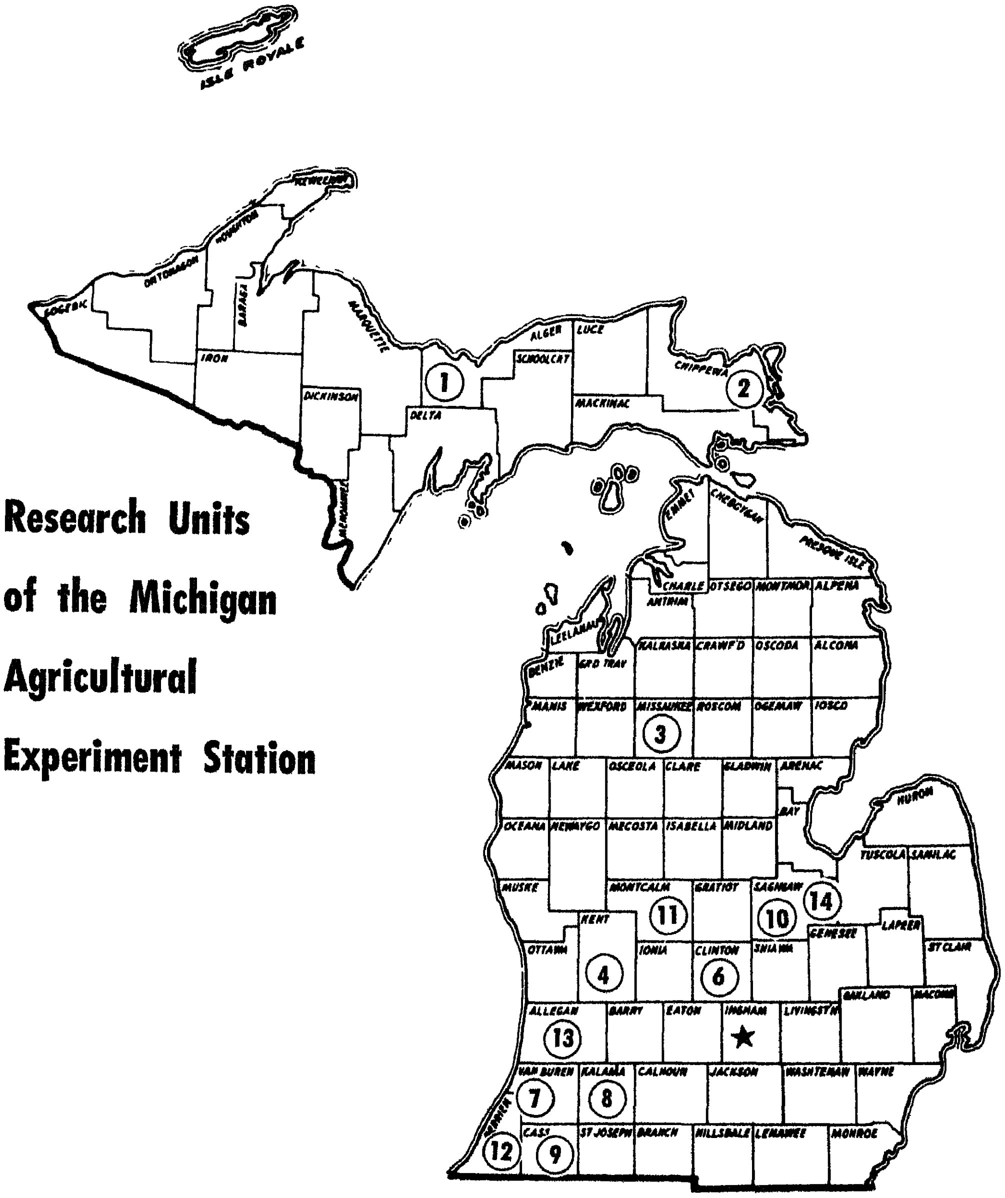
The Michigan Department of Natural Resources (DNR) looked at RB-57F and low-altitude, multispectral remote imagery to identify vegetation types in the Pointe Mouillee Wildfowl Feed Area south of Detroit. The DNR then improved the menu for wild ducks by replacing non-nutritious plants with more beneficial ones.

MSU remote sensing personnel are also helping the Wayne County Planning Commission develop agricultural, open space and recreational land policy. These specialists interpret sensing maps so that agricultural, soil and planning experts may decide from special location and productivity of the land which acres should be reserved for cropland or recreation and which may be developed for urban use.

"The decision will be made by Wayne County officials," said Schar, "but we hope that remote sensing will have made a valuable contribution to the decision-making process."

Taken during a "ground truth" study of the Pointe Mouillee area, this photo helped remote sensing specialists identify the vegetation, flooded areas and natural waterways on remote sensing maps.

Research Units of the Michigan Agricultural Experiment Station



① Upper Peninsula Experiment Station, Chatham. Established 1907. Beef, dairy, soils and crops. In addition to the station proper, there is the Jim Wells Forest.

② Dunbar Forest Experiment Station, Sault Ste, Marie. Established 1925, forest management.

③ Lake City Experiment Station, Lake City. Established 1928. Breeding, feeding and management of beef cattle; and fish pond production studies.

④ Graham Horticultural Experiment Station, Grand Rapids. Established 1919. Varieties, orchard soil management, spray methods.

★ Michigan Agricultural Experiment Station, Headquarters, 101 Agriculture Hall, MSU, East Lansing. Established 1888. Research work in all phases of Michigan agriculture and related fields.

⑥ Muck Experimental Farm, Laingsburg. Plots established 1941, crop production practices on organic soils.

⑦ South Haven Experiment Station, South Haven. Established 1890. Breeding peaches, blueberries, apricots. Small fruit management.

⑧ W. K. Kellogg Farm and Bird Sanctuary, Hickory Corners, and W. K. Kellogg Forest, Augusta. Established 1928. Forest management, wildlife studies, mink and dairy nutrition.

⑨ Fred Russ Forest, Cassopolis. Established 1942. Hardwood forest management.

⑩ Ferden Farm, Chesaning. Plots established 1928. Soi management, with special emphasis on sugar beets. (Land Leased)

⑪ Montcalm Experimental Farm, Entrican. Establishe 1966. Research on crops for processing, with specia emphasis on potatoes. (Land Leased)

⑫ Sodus Horticultural Experiment Station, Sodus. Established 1954. Production of small fruit and vegetabl crops. (Land Leased)

⑬ Trevor Nichols Experimental Farm, Fennville. Established 1967. Studies related to fruit crop productio with emphasis on pesticides research.

⑭ Saginaw Valley Beet and Bean Research Farm, Saginaw Established 1971. Studies related to production of suga beets and dry edible beans in rotation programs.

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This is the 26th in a series of "Science in Action" publications aimed at relating research developments in specific areas within Michigan State University's Agricultural Experiment Station.

In this publication, we've tried to briefly summarize some of the latest research information on **community development.** Further details are available from the following sources:

ADC Study — A. Allan Schmid, Departments of Agricultural Economics and Resource Development

Child Care — Jeanne Brown and Gaye Benson, Department of Family and Child Sciences

Facts Books — William Kimball, Department of Resource Development

Zoning Survey — Charles Kaufman, Department of Resource Development

Citizen Survey — William Kimball, Department of Resource Development

Preferential Taxation — Raleigh Barlowe, Department of Resource Development

Remote Sensing — Stephen Schar, NASA Remote Sensing Project, Departments of Resource Development, and Urban Planning and Landscape Architecture

michigan SCIENCE IN ACTION

FROM THE MICHIGAN STATE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION, EAST LANSING

JULY 1974

27 FOCUS ON MECHANICAL HARVESTING

Introduction

Since the day Eve selected and harvested an apple from a tree in the Garden of Eden, we have been looking for an easier way to get fruits and vegetables from plant to mouth.

But until recently, Eve's method of hand selection and harvest had not been challenged.

In the modern world of machines, though, poor Eve's fate was inevitable.

Research conducted at Michigan State University by university researchers and scientists from the Agricultural Research Service (ARS) of the United States Department of Agriculture stationed at MSU, has led to mechanization of harvest and handling of many Michigan fruits and vegetables.

There are many benefits of harvesting fruits and vegetables by machine rather than by hand. The consumer enjoys an adequate supply of locally produced fruits and vegetables at prices he can afford. Without mechanization prices would be 25 to 100 percent higher.

Harvest mechanization means jobs and income for several rural Michigan communities. Many growers who hire seasonal and year-round help would have gone out of business without a mechanized harvest. In addition, more than a dozen new on-the-farm or near-the-farm processing plants were established in Michigan as a result of mechanization.

Harvest machinery produced by 11 Michigan companies is a $4-million business each year which translates into more rural jobs and income.

Michigan has led the nation in researching the practical use of machines in harvesting fruits and vegetables and many of the pioneer attempts of applying that research were made in the state.

Agricultural engineers at MSU and ARS developed principles, methods and equipment for harvesting and handling many crops.

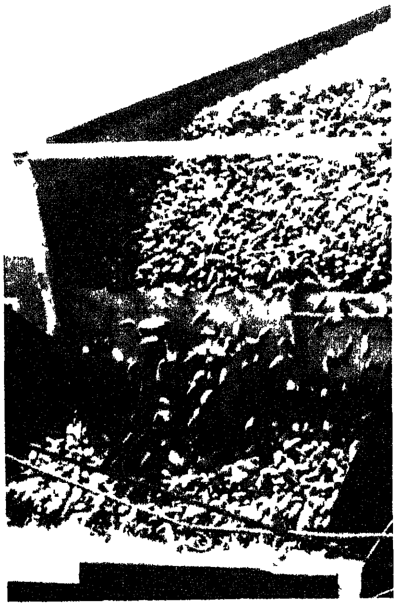
Horticulturists at MSU studying tree training, cultural practices, and plant genetics have discovered a chemical that causes fruit to ripen at a uniform rate allowing shorter and easier harvest.

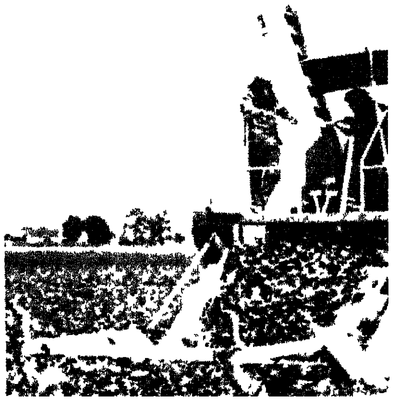
In addition, MSU and ARS food scientists have worked on quality maintenance and processing of mechanically harvested orchard fruits and vegetables.

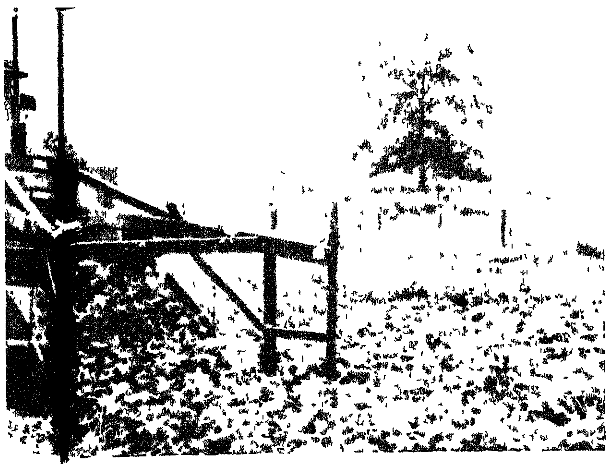
Research at MSU on weed control, disease control, higher crop yields, fertilizer research etc. has indirectly benefitted mechanical harvesting.

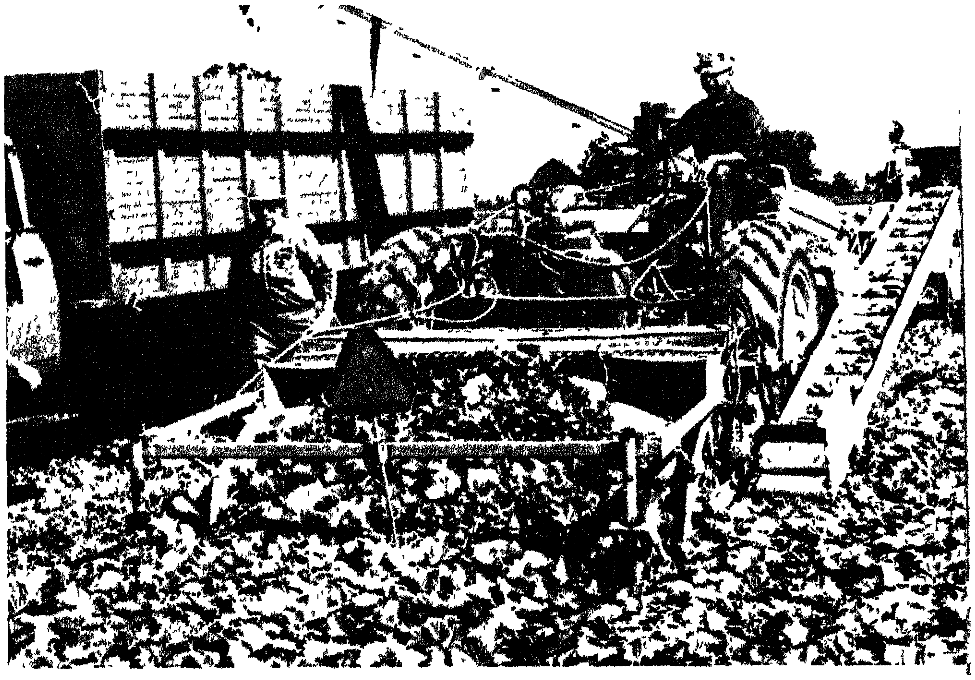
The cucumber harvester shown here discharges the crop directly into a self-unloading field trailer. Most of the cucumber harvesters used in the United States are made in Michigan.

About 20 tons of cucumbers are shown being unloaded at a Michigan processing plant. Machines harvest the crop so rapidly that it must be transported in bulk quantities.









This harvester discharges directly into a transport vehicle as it collects the crop from the field. Michigan has led the nation in pickle production every year but two since 1918.

Machines Save Pickle Industry

In 1968, pickle companies were seriously considering moving out of Michigan, the nation's leader in pickle production.

Although there were 180 bushels of cucumbers per acre, harvesters could only deliver 90 bushels for processing Suitable labor was not available for hand harvest and growers could not stay in business with crop yields of only 50 percent.

Now, with more than 92 percent of the cucumbers in the state harvested by machine and with better cultural practices, more than 200 bushels per acre can be processed. This is more than a 100 percent increase.

Improved once-over harvesting was the answer to the yield problem This method relies on picking the crop when the number of ready-to-harvest cucumbers in the field is greatest.

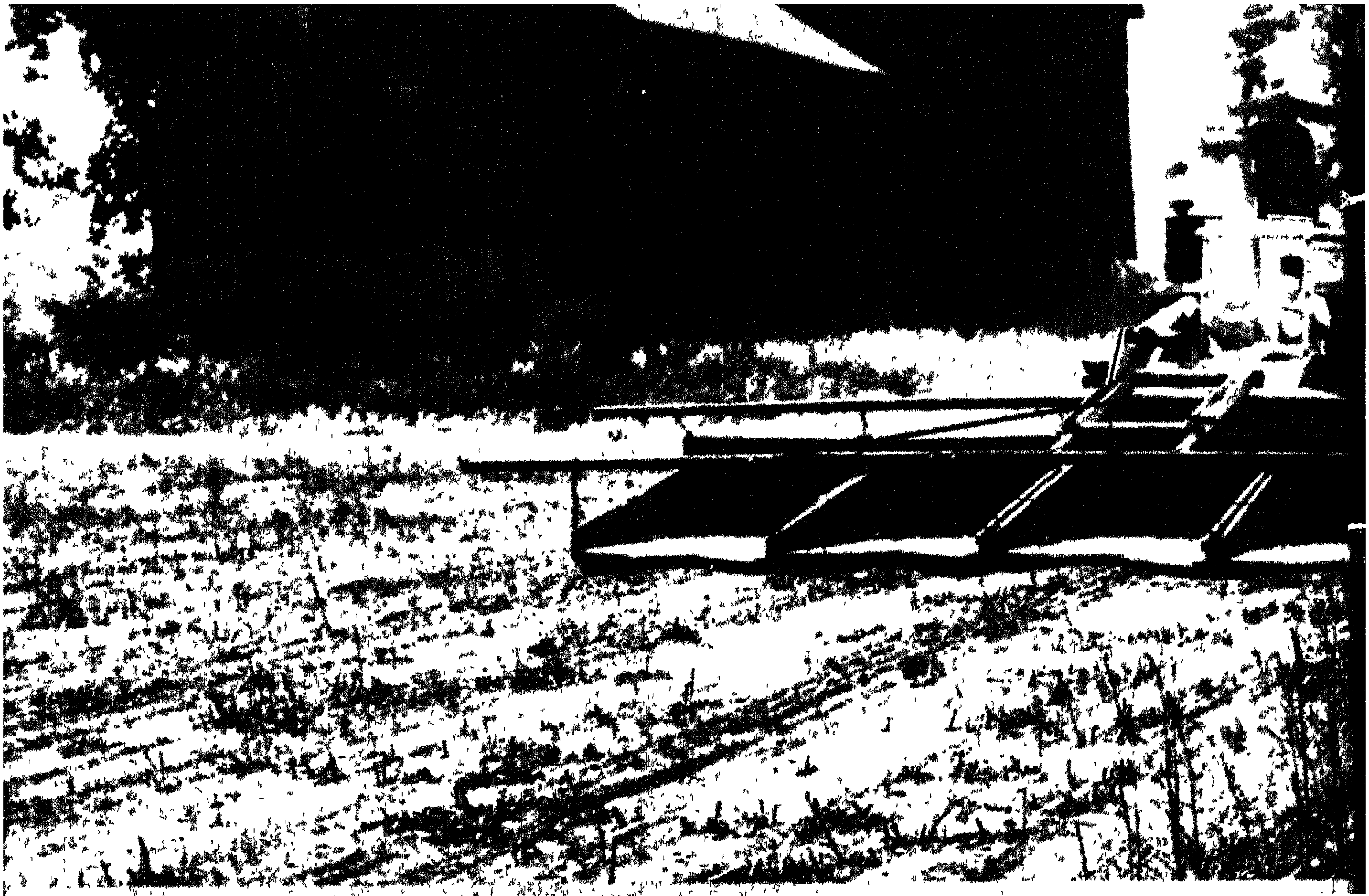
Determining this optimum harvest date is crucial because as many as 40 percent of the cucumbers could become oversized and of no value in 24 hours.

As a result, Michigan held its position as the leader in pickle production and the future looks bright.

Cucumbers

Year	% Mechanically Harvested	
	Michigan	U.S. (excluding Michigan)
1968	15	1
1969	35	
1970	65	
1971	85	
1972	90	
1973	92 (23,000 acres)	5 (9,000 acres)
1974	92+	

Opposite: A once-over pickle harvester operating in a Michigan field. Of the 29,000 cucumber acres harvested in Michigan in 1973, more than 27,000 were done by machine.



Sleds for Asparagus, Too!

Much time and effort were spent trying to develop a practical machine to harvest asparagus. After several years researchers thought they had a machine that, despite its cost, could speed harvest considerably.

But an incredibly simple and inexpensive device assembled by an asparagus grower in his backyard and towed behind his tractor seems to have caught the scientists, as one put it, "with our pants down."

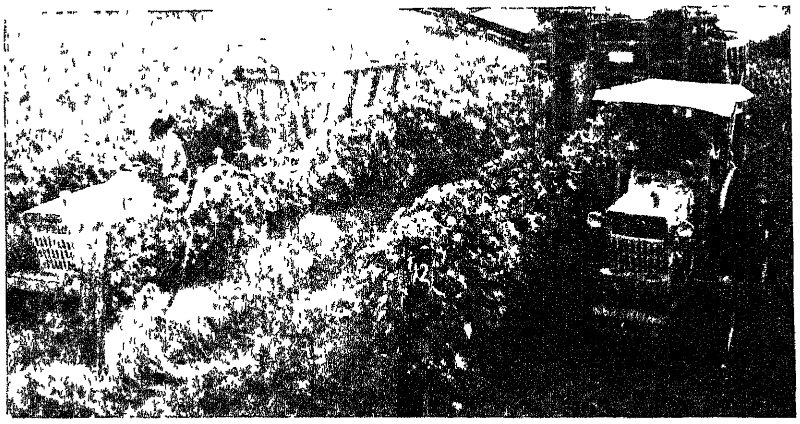
The "machine" consists of four two-by-fours nailed together with a sheet of plywood nailed on top. The apparatus, which resembles a sled, has a "V" shaped front to which huge saw-blades are fastened.

As the sled is dragged through the asparagus at 15 to 20 mph, the vegetable is cut by the blades and flies back to the waiting platform. In an average day, 120 acres can be harvested by one person using this method and 60 percent of the crop is recovered.

Thanks largely to this method of harvest, Michigan's asparagus acreage has increased while that of New Jersey and other leading states has decreased due to harvest difficulties.

Five "sleds" are being pushed through an asparagus field. The front of the sled is V-shaped and its sharp edges cut the crop which flies back into the sled. This simple idea has helped increase asparagus acreage in Michigan.

Asparagus is dumped into a field trailer which will deliver it for shipment to the processing plant.



One of the more than 50 grape harvesters used in Michigan to harvest more than 90 percent of the crop. This over-the-row harvester discharges the grapes directly into a 3½ ton hydraulic dumping trailer.

Tramping Out The Vintage

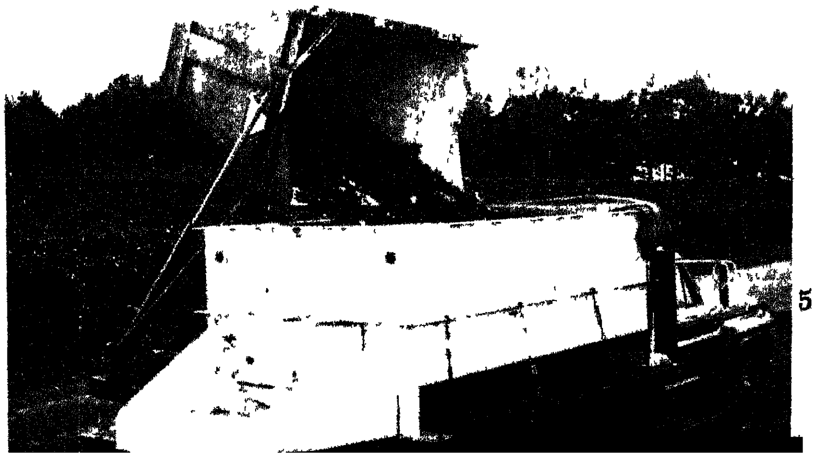
During the past four years MSU and ARS scientists have developed a complete bulk-handling system for mechanically harvested grapes The system, which employs a self-unloading vehicle in the vineyard, saves three men, two fork-lift trucks and about $4,000 per harvester.

The quality of the juice made from bulk handled grapes is equal or superior to that of conventionally handled grapes.

Applying machines to the harvest has allowed grape growers to expand their business in Michigan.

Grapes			
	% Mechanically Harvested		
Year	Michigan	California	New York
1968	1	0	2
1969	25		
1970	65		
1971	85		
1972	90		
1973	93+	15	93+

A bulk tank mounted on a flat-bed truck receives the fruit from the dumper. The juice quality of bulk handled grapes is equal or superior to that of conventionally handled grapes.



Sweet cherries shaken from the tree fall to an inclined catcher (pictured here) and roll to a conveyor. The conveyor moves them to pallet boxes that can be easily moved by fork-lift.

"Shaking Up" the Cherry Industry

SWEET CHERRIES

In 1969, the future of sweet cherry production in Michig looked bleak.

Due to the high cost of harvesting by hand (6¢ to harvest pound worth only 6½¢), sweet cherry growers were faced w three alternatives: they could 1) remove their trees, 2) not ha the crop or 3) go to a mechanical harvesting process then be developed.

A change to mechanical harvesting, which costs only a p a pound was the only workable choice. Now the industry is the increase.

MSU and ARS horticulturists made mechanical harvesting possible for sweet cherries by developing ethrel, a chemical s which loosens the cherry from the tree. With ethrel less forc needed to shake the fruit from the tree resulting in more fru harvested with less damage to fruit or tree.

	Sweet Cherries				
	Michigan		% Mech Harvested		
Year	% Mech. Harv.	Sprayed With Ethrel	Calif.	Wash.	Oregon
1965	5	0	0	0	0
1970	15	0	0	0	5
1973	95	80%	5	0	20

TART CHERRIES

Agricultural engineers from MSU and ARS have developed, or helped develop, methods and equipment for harvesting and handling tart cherries mechanically.

Tree shakers and collection apparatus which deposit the cherries into pallet tanks (water tanks that can be transported by fork-lift) were designed by MSU scientists.

MSU and ARS also promoted the idea of water handling cherries. Transporting cherries in water has several advantages: heat damage and bruising are kept to a minimum; the firming action needed for easy pitting begins in water; and trash, like leaves and wood pieces, floats to the surface of the tanks and can be eliminated.

The problem of pricing cherries by weight, which would necessitate draining, was solved when the researchers introduced the idea of volume buying. The process is as accurate as weighing and the cherries can remain in water—avoiding the risk of damage in handling.

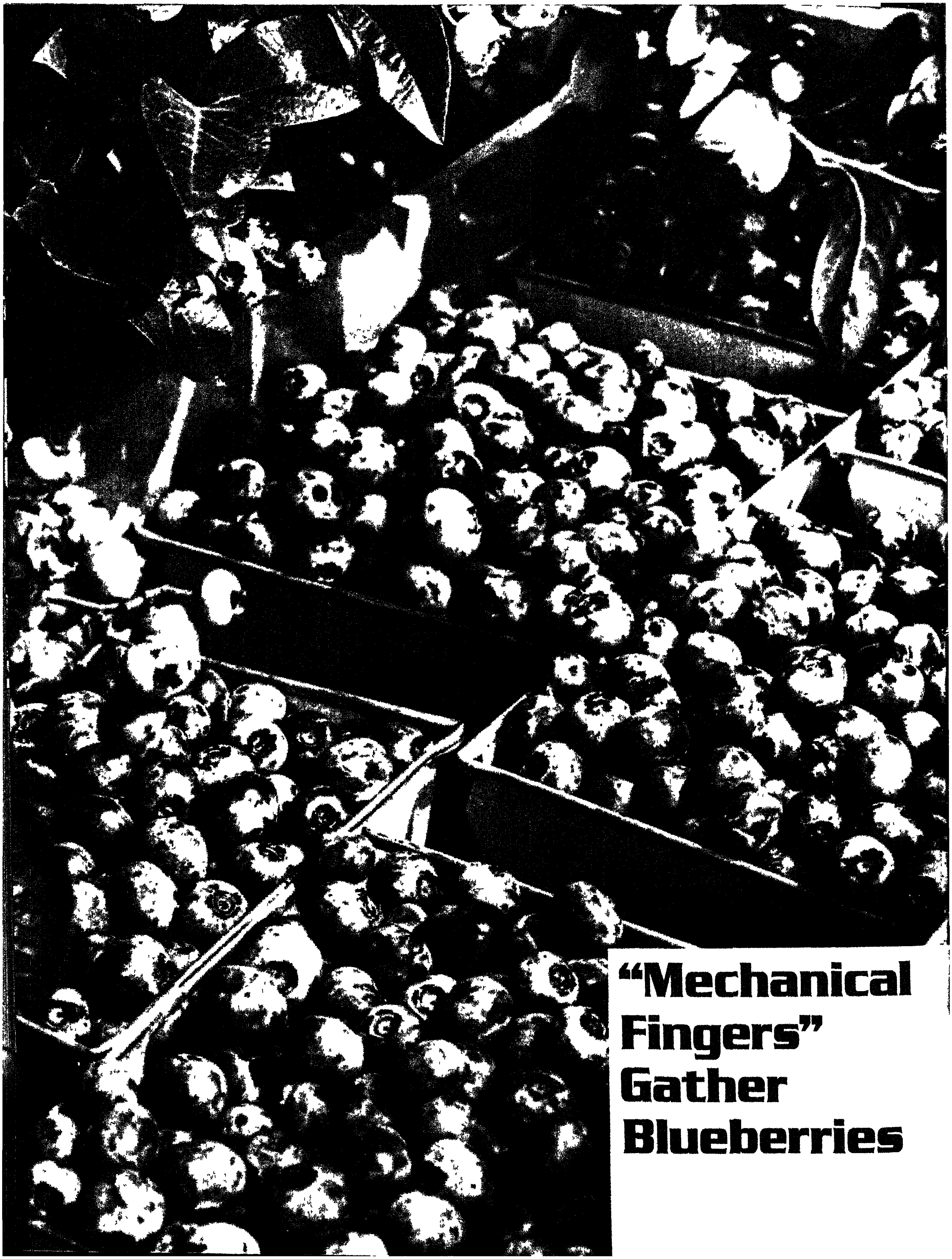
Horticulturists at MSU developed tree-pruning methods which allow tart cherries to be mechanically harvested faster and easier and with less damage to the tree. Fruit recovery for pruned trees is essentially the same as that for unpruned trees.

	Tart Cherries			
	Michigan		U.S. (other states)	
Year	No. Machines	% of Crop Machine Harvested	No. Machines	% of Crop Machine Harvested
1961	1	0	0	0
1973	1200 (in use)	95%	500	85

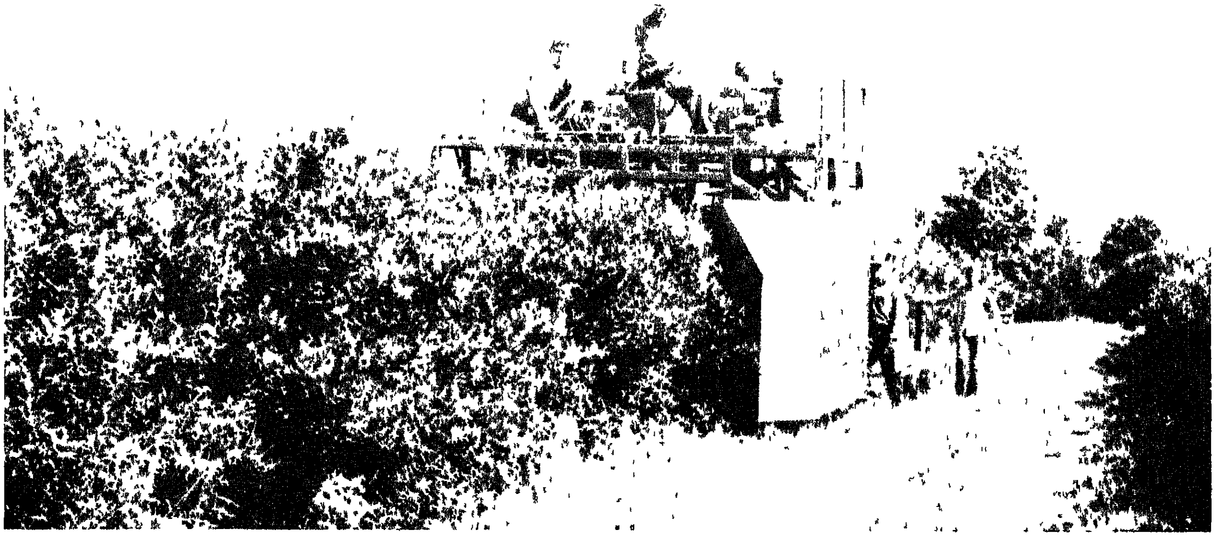
Tart cherries are handled strictly by machine from tree to processing plant. Nearly 1,000 pounds of tart cherries are being dumped out of a pallet tank into a receiving hopper at the plant. Aided by machines, two men now handle as many cherries as 40 men can using conventional methods.

The volume [illegible] cherries [illegible]

[illegible] of the crop. This [illegible] MSU and ARS [illegible] damage [illegible]



“Mechanical Fingers” Gather Blueberries



This over-the-row continuous harvester detaches blueberries by vibration and separates the fruit from leaves and other material using a fan. Each of the more than 150 blueberry harvesters made in Michigan will do the work of 200 hand pickers in the same amount of time.

Hand-held vibrators, like the one here, allow the worker to pick eight times faster than by hand. More than 3,000 of the Michigan-made units have been sold in the state.

Scientists at MSU developed hand-held vibrators which increase a harvester's efficiency by 800 percent, and greatly increase pickers wages More than 3,000 were sold to blueberry growers in Michigan.

Ethrel, the same chemical that loosens cherries, will also loosen blueberries so less force is needed to remove the fruit and less plant damage results.

MSU and ARS scientists developed principles for an over the row continuous harvester The machine used to harvest the fruit is shaped like an inverted "U" and straddles a row of blueberries The operator sits directly over the row as the machine's vibrating "fingers" knock the fruit into plastic catching frames that guide the berries onto a conveyer.

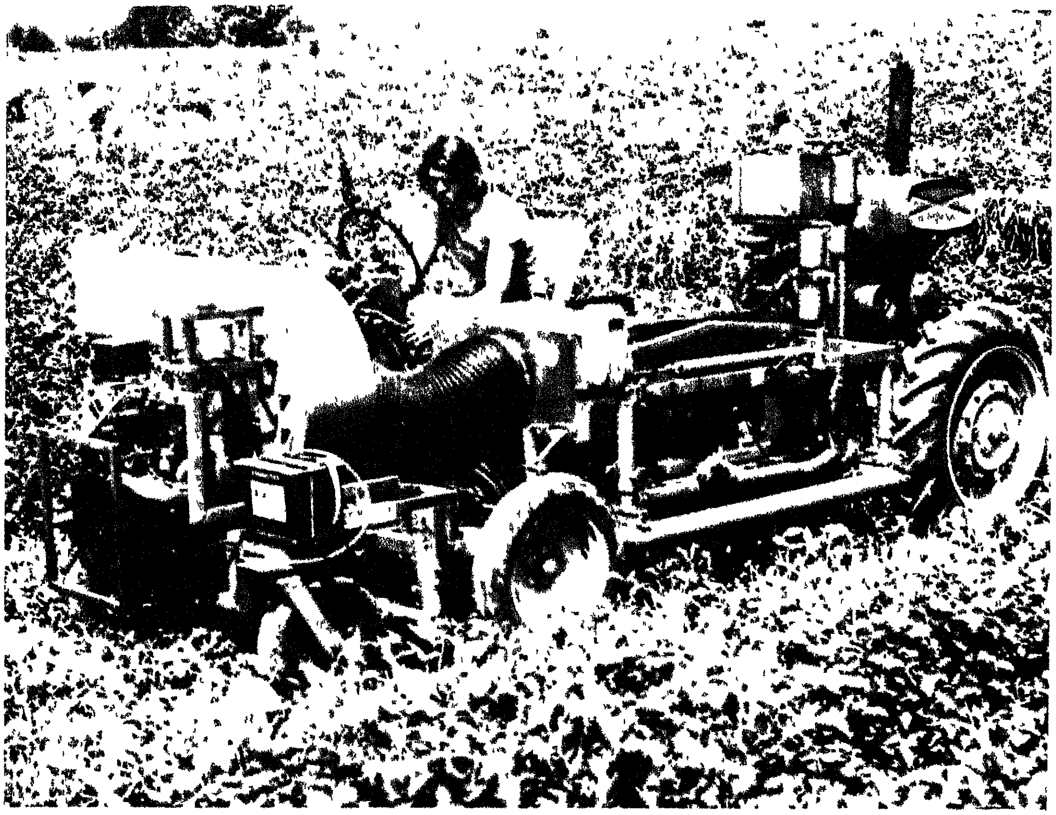
The machines allow a much higher percentage of the crop to be harvested and make possible great increases in production Michigan is by far the leader in blueberry production.

1973 Blueberry Production
(North American Blueberry Council)

Michigan	38,500,000 lb
New Jersey	24,893,000 lb
North Carolina	7,151,000 lb
Washington	4,105,000 lb
Oregon	1,063,000 lb

Max Lane, a Lawrence, Michigan grower, inspects mechanically harvested apples about to be transported by fork-lift. It is estimated that one-and-a-half million bushels of Michigan apples will be harvested by machine in 1974. The apples are used for sauce, slices and juice.

The apparatus (far right) is harvesting cabbage. The harvester detaches the crop which is then put on a conveyor that carries it to the field vehicle (left).



An early version of an experimental MSU strawberry harvester. Strawberry acreage has been decreasing in Michigan due to high cost of hand harvest and inability to find harvest workers.

This experimental machine is picking up apples that have dropped to the ground. Five to 10 percent of all apples fall in a given ar and as many as 50 percent can fall during storm. The first apple pick-up machine developed by ARS and MSU led to similar machines being developed in New York, Great Britain and other places.

Peter Piper Replaced

Research is underway on developing techniques for mechanically harvesting other crops like peppers, apples, pears, cabbage, tomatoes and strawberries.

Mechanization would allow these crops to be grown in Michigan Without it these crops will decline and eventually disappear from the state. Strawberries, for example, have already decreased from over 9,000 acres in 1960 to less than 3,500 acres in 1973.

If future research in the area of mechanical harvesting can enjoy a mere percentage of the past's success, Michigan's fruit and vegetable growers have something to look forward to.

Section 37.20, P. L. & R.

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FIRST CLASS

This is the 27th in a series of "**Science in Action**" publications aimed at relating research developments in specific areas within Michigan State University's Agricultural Experiment Station.

In this publication, we've tried to briefly summarize some of the latest research information on mechanical harvesting in Michigan. Further details are available from the following sources:

Department of Agricultural Engineering

Burton Cargill, Clarence Hansen; Jordan H. Levin (ARS, USDA); Dale E. Marshall (ARS, USDA); and Bernie Tennes (ARS, USDA)

Food Science

Cliff Bedford and Dennis Heldman.

Horticulture

Larry Baker, Martin Bukovac, Stan Howell, A. L. Kenworthy, Jim Motes, and Hugh Price.

michigan SCIENCE IN ACTION
FROM THE MICHIGAN STATE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION, EAST LANSING
MARCH 1975

28 Science and the Home Garden

Science and the Home Garden

Backyard gardens are booming. More people are planting bigger gardens than ever before. Even more than in Victory Garden days of World War II. Where do people turn for help? To the experts at Michigan State University.

Research at MSU has benefited the home food gardener in dozens of ways. New and better varieties, tried and tested pest control methods and information on how and when to plant and pick are only some of them. To find out about these and others, read on.

Sonnette, a new variety of bell pepper, resists tobacco mosaic disease.

New Varieties to Avoid Old Problems

Improved nutrition, higher yields, disease and insect resistance, better eye appeal, longer shelf life and improved flavor are some of the aims of research on new plant varieties at Michigan State University.

Though much of the research on new varieties and hybrids is aimed at the commercial grower who grows for the consumer, the benefits to the home gardener are many, says Shigemi Honma, plant breeder and professor of horticulture.

"One of our main aims is to produce vegetables resistant to disease," he says. "Disease resistance is very important to the home gardener because he must use the same plot of land every year. Soil-borne disease organisms live in the soil for years. A commercial grower often can rotate his crops a half-mile down the road to get away from last year's disease problems, but the home gardener can't do this. So we try to produce varieties that will resist the organisms they can't get away from."

A recent development is Sonnette, a bell pepper that resists tobacco mosaic disease.

"Insect resistance will take a little longer," Dr. Honma notes.

Currently, research on insect resistance is focusing on the corn borer, a pest of snapbeans and peppers as well as sweet corn.

"There are already a couple of varieties of sweet corn that resist the first brood of the corn borer," Dr. Honma points out. "But four years of research on peppers hasn't turned up a borer-resistant plant, so we have turned to studying the insect to find out where and how it enters the pepper.

"Perhaps we could change the shape of the fruit or the way the plant bears the fruit that would prevent the worm from entering. We are also trying to find out whether there is a natural substance in peppers like that in corn borer resistance in sweet corn that would discourage the larva from entering the stalk."

A new type of cauliflower, "Self-Blanche", developed at MSU could be classified as a laborsaving device for the home gardener. It is a self-blanching type: leaves curl over the developing head and protect it from the sun. The head stays white without the time-consuming process of hand-tying the leaves over the heads required by conventional cauliflower varieties.

Dr. Honma and other researchers are now trying to breed a cauliflower that matures in August rather than September. Cauliflower heads tied or covered in August would get mushy from the heat, so the scientists are trying to change the angle of the leaves to protect the head from direct sun without overheating. They are trying to achieve an acceptable pale head color in heads that can not be tied.

"One sure thing about plant breeding is that we will never run out of problems," Dr. Honma says. "Disease and insects change as plants change, so we will never be completely free of them. And there will always be improvements to be made in yield, appearance and nutrition."

Dr. Shigemi Honma demonstrates the curling leaves of "Self Blanche," a new laborsaving cauliflower type developed at MSU.

New Berries Look Like Winners

It takes 10 years of painstaking work and patient waiting to produce a new strawberry variety. And then it may not be accepted.

A strawberry in the works now at MSU looks like a winner, though.

"It doesn't have a name yet, just a number, M 833," says Dr. James E. Moulton, plant breeder and professor of horticulture. "But indications are that it will be much more productive than many standard varieties. It produces a very large, attractive berry that's firm, keeps well, has good color, tastes good fresh and freezes well. And the plants are disease-resistant."

Dr. Moulton has been working on M 833 for about six years and figures it will take another three to four years before it will be available.

Also nearly ready for introduction is a dwarf blueberry. As with many dwarf varieties, its main value will probably be as an ornamental. It grows to about the size of a half-bushel basket, so it is small enough to be grown as a potted plant on the patio. It could even be sold packaged like roses, Dr. Moulton says.

New strawberries and blueberries are just part of the work going on at MSU's South Haven Experiment Station. About 15 new varieties of peaches, apricots, raspberries and blueberries have been developed there over the years; and work continues to find new ones and to see how varieties from other states will perform under Michigan conditions. The result is better fruit for you, whether you buy it at the grocery store or grow it yourself.

New M 833 strawberries (left) taste as good and freeze as well as an old favorite, Midway (right)—but the berries are larger.

Sour Grapes?
Not at MSU!

You can grow grapes for eating or making juice, jelly or wine in your own backyard. And it's easier these days, thanks to research going on at MSU.

Test plots all across the Lower Peninsula and one in the Upper Peninsula are helping MSU's grape researcher find out which varieties grow best in what locations.

"Some grape varieties require longer growing seasons than some parts of Michigan provide," says Stan Howell, associate professor of horticulture. "We've found seven or eight varieties that will grow in various parts of the state, though, and we're growing them in our test plots to find the extent of the area in which each variety can be grown."

The test plots are also yielding information on vine hardiness and disease and insect resistance. Improved techniques for growing grapes have come out of the test plots, too, Dr. Howell says. Cluster thinning is one of these.

"Thinning the grape clusters prevents overproduction of fruit," he explains. "Overproduction weakens the vines, and they frequently will not survive the next winter. Cluster thinning strengthens the vines and improves the quality of the fruit."

Want to know the best use for the grape variety you already have or the best variety for the use you have in mind? The MSU scientist has tried out different varieties and can tell you which are best for eating out of hand and making jams, jellies, juice and wine.

If the idea of growing grapes brings out the "little ole wine maker" in you, Dr. Howell can offer a couple of tips.

"The most frequent mistake of home wine makers is to drink their product too soon," he says. "Be patient and let it clear before you drink it. Also, be sure to use a commercial strain of wine yeast. If you don't, you have next to no chance of being able to reproduce something that turns out really good."

Caging tomatoes offers the advantages of trellising at a lower cost.

Caging Tomatoes / Pays Off

Commercial growers have known for years that the highest quality tomatoes are grown on trellises. But trellising requires at least 1,000 man-hours of labor per acre. The expense of pruning and tying the plants is prohibitive on any large scale, so for years growers continued to grow their tomatoes on the ground and suffer the consequences: ground stains, insect problems, poor marketable yields.

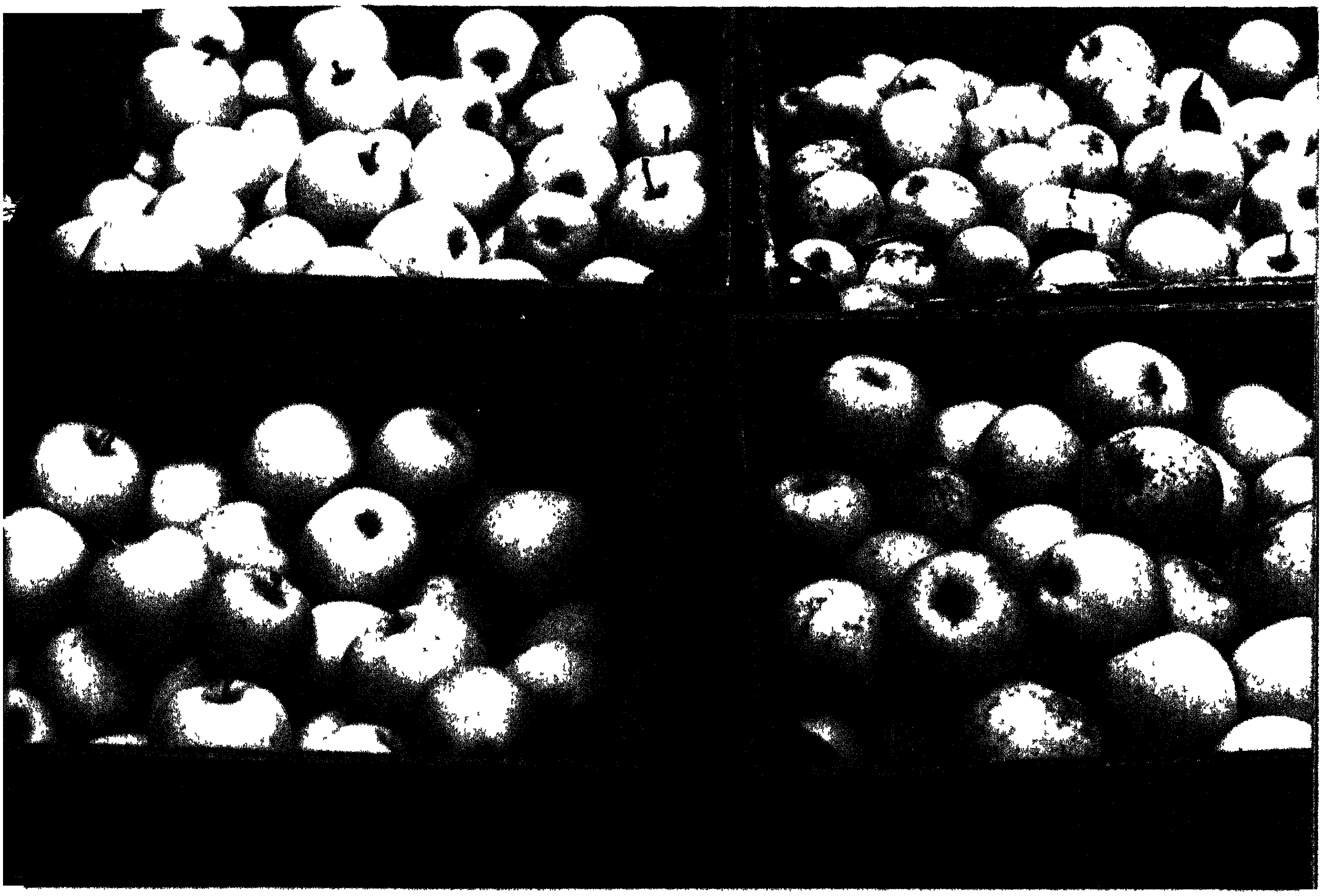
Then a grower developed the technique of caging tomatoes. He found that, by growing his tomato plants up through a circular "cage" of steel concrete reinforcing wire, he could have most of the advantages of trellising at a lower cost.

Scientists in horticulture at MSU have investigated the claims made for caging and verified it as practical and beneficial. Its main use, however, seems to be for the home gardener rather than the commercial grower.

"The sheer logistics of getting the cages out and taking them in makes caging less practical for the commercial grower with thousands of plants than for the home gardener with a dozen or so," says Dr. Hugh Price, associate professor of horticulture. "One small drawback is that those first few tomatoes are a little hard to pick, because they're way inside the cage. If you use a variety that adapts well to caging, though, you shouldn't have any problems with the later ones."

Determinant varieties—those that don't grow beyond a certain height—are best, he advises. Jet Star, Campbell 1327, Setmore and Springset do well in cages, he notes. Indeterminant varieties—plants that keep growing larger and larger—will grow out the tops of the cages and trail down the outsides.

"After a while, these get to be pretty impossible," Dr. Price notes.



The golden delicious apples on the left are more resistant to russetting than those on the right.

Overcoming the pitfalls of Fruit Growing

Growing fruit trees in your backyard is not easy, but the home gardener can have some success, thanks in part to fruit tree research at MSU.

New and better varieties, improved rootstocks, better cultural techniques, and advances in insect and disease control are primarily for the commercial fruit grower, says Jerome Hull, professor of horticulture. But the home gardener can benefit, too.

"Research has shown that a systematic insect and disease control program is a must," Dr. Hull says. "Insecticide-fungicide combinations are available to control most disease and insect problems if you apply the chemicals regularly."

Apple trees, for instance, must be sprayed about once a week from the time the green leaves begin to appear until the flower petals fall, then spray once every 10 days until September, he prescribes. Miss one timely application and your whole crop can be lost to disease or insects. Problems of disease and insects tend to intensify as the years go by, Dr. Hull notes.

Other pitfalls the home gardener should be aware of include a poor site, poor drainage, poor varieties, and birds, if he's growing sweet or tart cherries.

"Few tree fruit varieties are adaptable to areas outside a narrow strip of land along the western coast of Michigan," Dr. Hull explains. "Away from the climate-modifying lake, cold winter temperatures often kill developing flower buds."

Fruit trees must have good drainage. "In heavy clay soils that hold a lot of water, roots frequently die for lack of oxygen."

Even if you do everything "by the book," your yield will vary from year to year.

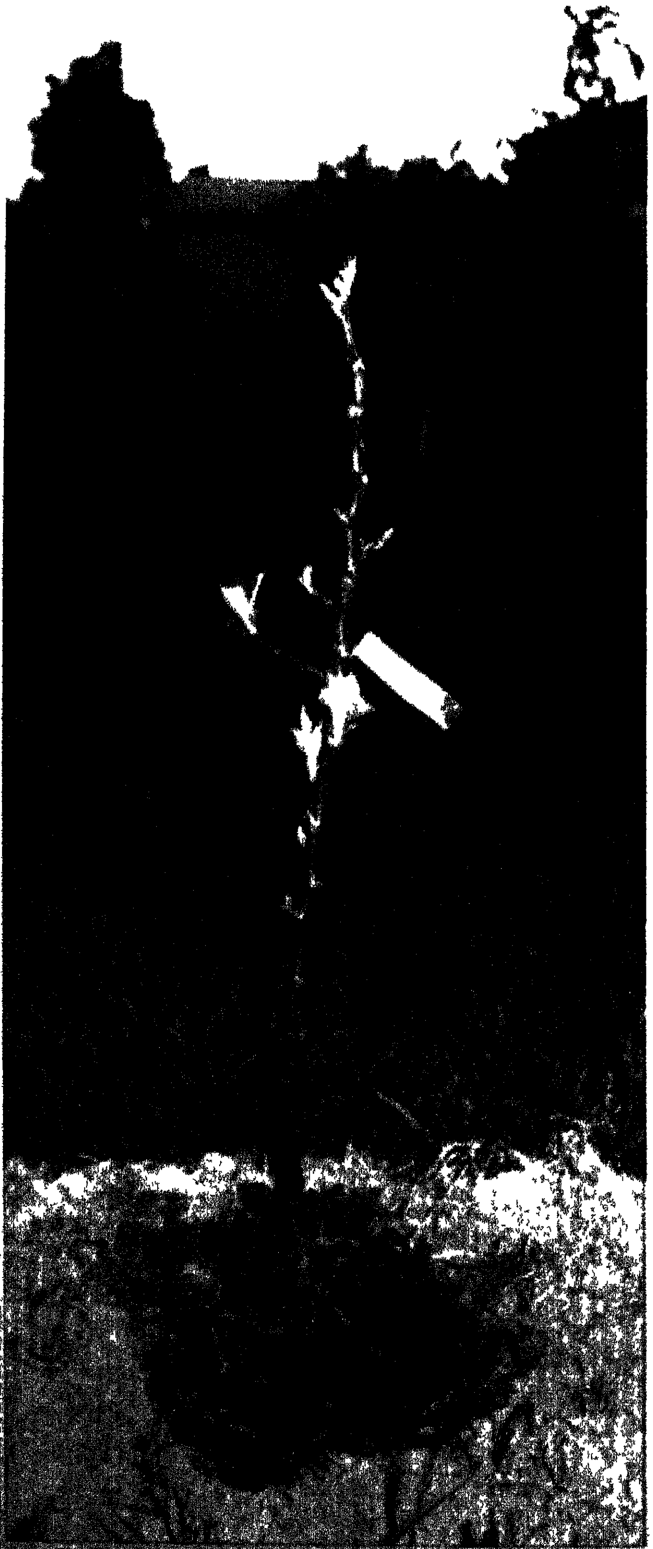
Research continues to develop new varieties that will be hardier or more disease resistant. Varieties are also grafted onto rootstocks and researchers are evaluating new rootstocks that produce trees with certain characteristics, such as dwarfism.

MSU horticulturists have been working to develop small, compact fruit trees for 25 years. The trees they have produced can be planted more densely than normal-sized trees. This is a plus for the backyard gardener who doesn't have a large area to plant in trees. Dwarf fruit trees do not produce as much fruit per tree as normal-sized trees, but they start bearing 4 to 8 years earlier.

Dwarf fruit trees are no guarantee of success, however. A regular spray program is a must, as are pruning and trimming. The small size of the trees does make these chores somewhat easier, of course.

For up-to-date information on fruit growing in your particular area, contact your local Extension horticulture agent.

Dwarf fruit trees produce lots of easily harvested fruit.



A circle of cleared ground and a ring of hardware cloth around the trunk help protect young backyard fruit trees from the mower. Remove the identification tag before planting to keep the wire from cutting into the branch as it grows.

Fungicides Protect Fruit Trees

Protecting your apple trees against disease can be a little less work these days, thanks to fungicide research at MSU.

Difolatan is a chemical used to control apple scab, a major problem of home fruit growers. Dr. Edward Klos, professor of Botany and Plant Pathology, explains how Difolatan takes some of the work out of apple growing.

"It is a single application compound," he says. "One spraying when the trees are at the green tip stage will protect them against apple scab until the petals fall. If you used one of the other standard treatments, you would have to spray every 5 to 7 days starting at green tip until petal fall."

Research on using a combination of Difolatan until petal fall and then two or three sprayings of Benlate indicates these four sprayings will protect against apple scab for the whole year. If you used a standard fungicide alone, as many as 15 sprayings would be required. With Difolatan you spray less often and spend less money on application of chemicals.

Research is being done, using Difolatan as a control for cherry leaf spot, another fungus disease. One spraying of Difolatan when the leaves first unfold and one spray of Benlate just before harvest controls leaf spot very effectively, Dr. Klos says. These two sprays replace a minimum of five sprays with a recommended fungicide.

One drawback with Difolatan is that it causes an allergic reaction in some people, Dr. Klos notes. It is currently approved for use on cherries only if they will be shaken from the trees. It can be used on apples because there is enough time between spraying and picking for weathering to remove most traces of it.

To reduce the number of spray applications and cut spray waste, MSU scientists are working on a disease monitoring system to keep close tabs on environmental conditions and pathogen development such as spore discharge. The aim is to time sprays for maximum effect.

"The system has already helped scientists find that the first spray for plum black knot was being put on too late," Dr. Klos says.

The researchers are also studying the overwintering of the organism that causes fireblight on apples and pears so the first spray can be timed to eliminate the bacteria before they get established.

Prevent Disease Problems in Vegetable Garden

Many vegetable diseases that may plague your garden are like some human ailments: it's a lot easier to prevent than to cure them.

One way to keep diseases from getting established in your garden is to keep your plants strong and healthy, says H. Spencer Potter, MSU researcher in plant disease. Healthy plants resist disease better than unhealthy ones, he explains.

"Start your disease prevention program by picking a good site for the garden," Dr. Potter advises. "Look for a well drained spot with plenty of sunlight and available water. These are necessary for plant health."

Don't put the garden in a low spot that holds damp, stagnant air, he warns. Most disease organisms need moisture to invade and injure plants. A site with little or no movement or air in and out sets up ideal humid conditions for disease organisms to get established.

A soil test is a very important part of a disease prevention program, Dr. Potter says. Putting on fertilizer you don't need can be as bad as fertilizing too little. An oversupply of nutrients can injure a plant's root system, he explains, making the plants vulnerable to attack by disease organisms.

"Too much of one nutrient can also prevent a plant from taking up other nutrients it needs, even if they are present in the soil," he adds. "The end result is a weak plant susceptible to infection."

The varieties you grow can be a big factor in minimizing disease problems, the scientist says. Some plant varieties are resistant to disease; others are quite susceptible. Read the seed catalogue or seed package carefully, and look for varieties with disease resistance. Then buy your seed from a reputable seed dealer.

"Seed grown in the western United States is best," Dr. Potter says. "The climate there is generally dry and the seed is less likely to be infected with disease than seed grown in more humid areas."

Seed should be treated with a fungicide before it is planted, he advises. Buy pretreated seed or treat it yourself with Captan or Thiram, following label directions.

Seed treatment is important to prevent the spread of disease carried on the seed and to protect germinating seed from disease organisms in the garden soil. Around the time when the first root appears, the seedling is extremely susceptible to infection, Dr. Potter explains.

If you're buying transplants for the garden, get healthy ones that were grown locally, he suggests. You will probably get varieties suited to the area, and plants are likely to be in better condition if they haven't traveled a great distance.

You can also grow your own transplants. If you do, be sure to use clean containers, disease-free soil and clean tools. Purchase sterile soil or sterilize garden soil in a pressure cooker—steam it for as long as it would take to cook a whole potato—or in the oven—bake at 350 degrees for 1½-2 hours.

"You can also fumigate with one of several chemicals," Dr. Potter says. "Check with your local garden supply center or county Extension agent for information on proper equipment and procedures."

Once plants are in the garden, water to maintain proper soil moisture. Water so the soil at the root level will hold together without dripping when you squeeze a handful of it, Dr. Potter advises. Water as often as necessary to keep the garden from getting extremely dry between soakings—extreme fluctuations in soil moisture weaken plants. Avoid wetting the foliage if possible—this creates the moist conditions that promote disease.

"If you must spray the garden, do not do so in the late afternoon or early evening," he advises. "Plants will remain wet through the night and well into the next day, giving disease a good long time to get established.

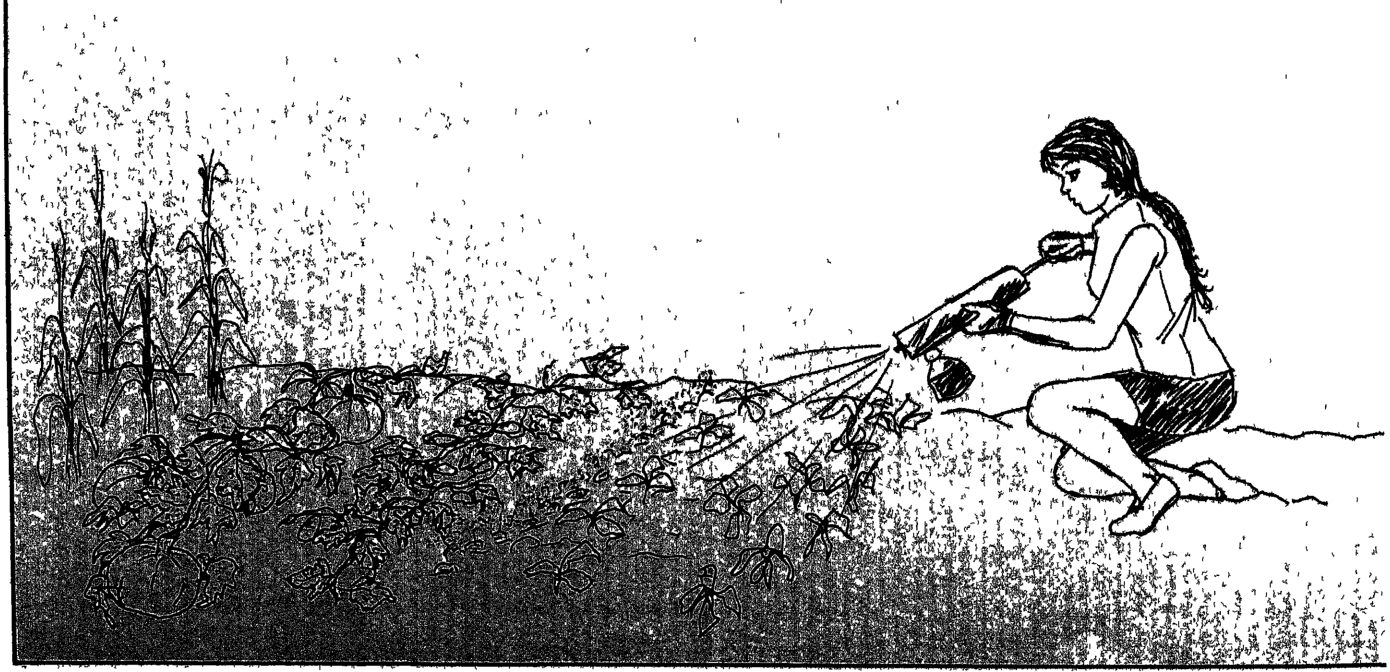
"Moisture on the foliage is necessary in most cases for infection to occur," he continues. "And many disease-causing fungi and bacteria need relatively few hours in the presence of moisture to invade the plant. So it's best to water early in the morning so plants can dry off quickly."

Weed control plays a part in disease prevention, too, Dr. Potter notes. Not only do weeds compete for soil moisture and nutrients, but they may also act as hosts for disease organisms and insects.

"Insect control is necessary for two reasons," he says. "Injuries caused by feeding insects give disease organisms a way into plant tissues. Also, many pests—including aphids, cucumber beetles and nematodes—transmit disease organisms. Controlling the insect is essential if you're going to control the disease."

Because many disease organisms live in the soil from one year to the next, it's a good idea to rotate crops so that closely related ones are not planted one after another. Sweet corn, for instance, should not be planted in the same spot every year, and tomatoes, eggplant and peppers should not follow each other two years in a row. These crops could be followed by squash, cucumbers, melons, beans, or beets, however.

At the end of the garden season, plow plant debris deep into the soil, Dr. Potter advises. Many disease organisms usually spend the winter on the surface in plant debris, he explains. Research shows that plowing them down cuts their chances of surviving to plague you next year. In the spring, plow shallow to avoid turning them up again.



Trickle Irrigation

In Israel they call it drip irrigation; in Australia, it's daily flow irrigation. In Michigan, where MSU scientists have been working with it since 1970, it's called trickle irrigation.

No matter what you call it, the principle is the same. small amounts of water are applied daily or otherwise frequently to prevent moisture deficiency in plants.

Formal research has focused on trickle irrigation for commercial fruit orchards in Michigan. Dr. A. L. Kenworthy, professor of horticulture, works with growers to find out how little water is required to produce beneficial results and how that water can best be carried to the trees.

Also, Dr. Kenworthy has built an automated system into his own large home garden.

"Trickle irrigation is low-pressure irrigation," he explains, "and uses considerably less water than other types of irrigation. I run my system for an hour a day—unless there has been a lot of rain—and draw all the water I need from the outdoor faucet on my house."

A main line carries water to the garden where a flow regulator controls how much water is delivered. Black plastic pipes run along each row and tiny plastic microtubes deliver a minute trickle of water to each hill. For vegetables with close spacing (beans, carrots) a dew hose is used.

Because only a narrow strip of soil is wetted, the garden is accessible at any time, Dr. Kenworthy points out. The areas between the rows also tend to remain relatively weed free. And he uses much less water to better effect than if he were to rely on sprinkling or watering with the garden hose.

Trickle irrigation does not provide frost protection. Dr. Kenworthy will soon test a new kind of emitter that may apply a mist over the plants and provide frost protection to crops such as strawberries.

Will trickle irrigation save you money? Possibly, "if you produce enough to pay for the water. How do you calculate the value of a home garden?" Dr. Kenworthy says.

Trickle irrigation uses much less water than other irrigation systems.

Feed the Soil - But Test it First

Planning on adding lime to your home vegetable garden this year? Better get your soil tested first. According to soil scientists at Michigan State University, your soil probably doesn't need lime.

The soil testing laboratory at MSU analyzed about 1,625 garden soil samples in 1974 Only about 17 percent of those tested actually needed liming, says Darryl Warncke, assistant professor of soil science

Lime is used to neutralize acid soil, he explains. Most of the samples tested in the lab fell in the satisfactory range—slightly acid to neutral—and 23 percent were already too alkaline. In most cases, therefore, liming would be unnecessary and even damaging.

"High alkalinity in the soil makes for inefficient use of soil nutrients," Warncke says. "Plant nutrients are used most efficiently between pH 6.0 and 7.0. Adding lime you don't need means extra expense: the costs of lime and other fertilizers you put down that your plants can't fully utilize."

Other commonly added nutrients may also be sufficient in the soil, he notes. Of the garden samples analyzed in 1974, 20 percent had very high phosphorus levels and 12 percent needed no additional potassium.

Whether and how much nitrogen should be added depends on the crop to be grown. Sweet corn, peppers, tomatoes, potatoes, cauliflower, broccoli and Brussels sprouts require relatively large amounts of supplemental nitrogen; 3-4 lbs per 1000 sq ft. Peas and beans require very little; 1 lb per 1000 sq ft; and onions, carrots, cabbage, beets, turnips, cucumbers and leaf lettuce fall somewhere in between.

The easiest and surest way to find out what your soil needs is to have a soil test run. Contact your county Extension office, Warncke advises. There you'll find out how to take the soil sample and get a postpaid sample box for sending your soil to the soil testing lab. Fertilizer and lime recommendations will be returned to you through your county office so that the horticulture or agriculture agent can adjust them, if necessary, to suit special county conditions.

"Computerized recommendations are available for nearly 70 field and garden crops," Warncke points out. "You may specify one crop or indicate a home garden with a variety of crops. In that case, the computer will give you one recommendation that best meets the needs of all the crops you intend to grow."

Two tests are available. The basic test (cost: $3) includes determination for soil pH (acidity-alkalinity), lime requirement, potassium and phosphorus. The regular test ($4) covers these as well as calcium and magnesium. For home gardeners, the basic test is usually all that's required, Warncke says, though homeowners with either very sandy or very acid soils might need the regular test.

Research at the soil testing lab is aimed at improving testing procedures for micronutrients: zinc, manganese and copper. With better tests, scientists will be better able to predict and prevent micronutrient deficiencies.

Range of phosphorus and potassium soil test levels in garden soils, 1974.

	% of samples	
	phosphorus	potassium
Very Low	16.2	24.0
Low	30.3	38.9
Medium	23.6	16.0
High	10.3	8.7
Very High	19.7	12.4

Nutrient	pH range of most availability
Nitrogen	5.5-7.5
Phosphorus	6.0-7.5
Potassium	above 5.5
Calcium	above 6.0
Magnesium	above 6.0
Molybdenum	above 6.0
Iron, Zn, Mn	below 6.5

Percent of 1974 garden soil samples having various levels of soil acidity or alkalinity.

	pH range	% of samples
Very acid	less than 5.0	1.2
Acid	5.0-5.9	15.7
Slightly acid	6.0-6.9	37.3
Slightly alkaline	7.0-7.4	22.9
Alkaline	above 7.5	22.8

Extending the Growing Season

When Michigan's already short growing season is combined with a cool, wet spring and an early fall frost, as in 1974, the result is often a summer's work in the home garden with very little to show for it.

MSU researchers haven't been able to change the climate or make the frost hold off, but they have found a couple of ways to extend your garden's growing season.

One way is to use starter solutions on transplants, says Dr. Hugh Price, associate professor of horticulture.

"When you move a transplant from a flat indoors to the garden spot, you're taking it from a very favorable environment to a very hostile one," Dr. Price explains. "The garden soil and the air are probably cooler than the plant is used to, and chances are that a good supply of phosphorus is not readily available. Phosphorus is necessary for proper root development. Without it the plant can not get quickly established in its new environment."

Starter solutions provide that needed phosphorus and get the plants off to a quick start. This can mean that crops start producing days earlier.

Another way to promote early growth and early harvest is to use black plastic mulch to warm the soil.

"Seeds will not germinate in the soil when the soil temperature is lower than 50–55 degrees F.," Dr. Price points out. "To warm the soil so seeds germinate soon after planting, work the soil until it's ready for seeds or transplants and then cover it with sheet plastic. The plastic will warm the soil so your crops can get an earlier start."

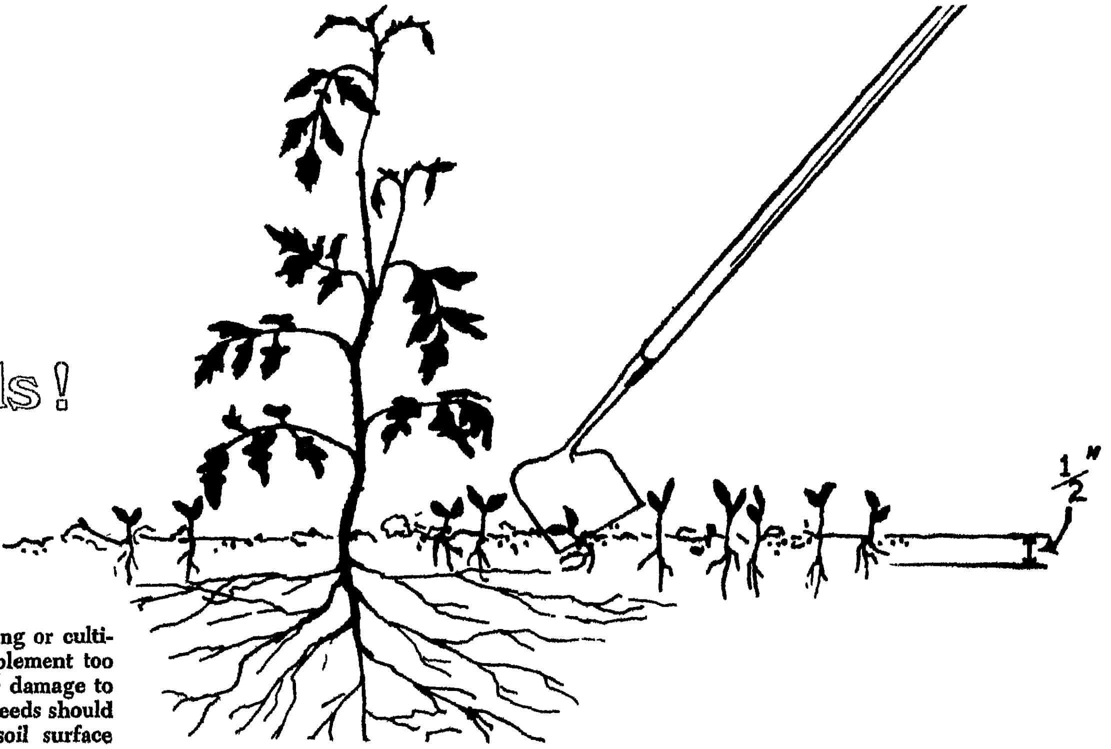
Clear plastic provides a better warming effect than black plastic, but MSU scientists recommend black plastic for home gardeners. Why? "Clear plastic does not control weeds," Dr. Price explains. "Black plastic cuts off sunlight so weeds can't grow." (More about this in "Fight the Weeds" section which follows.)

A drawback to plastic mulches is that you must take them off the garden in the fall, Dr. Price says. You can't treat them like organic mulches and simply plow them under. If you do, you have streamers of plastic working their way out for years.

To get around that problem, MSU researchers are trying to develop a biodegradable plastic mulch. It probably would not add nutrients to the soil as organic mulches do, but it would not be an environmental hazard.

Black plastic mulch warms the soil and promotes early growth.

Fight the Weeds!



A common mistake in hoeing or cultivating is sweeping the implement too deeply, which often causes damage to roots of the crop plant. Weeds should be cut off close to the soil surface when they are very small.

The harried home gardener looked up at the visitor, sagged tiredly against his hoe handle and mopped the beaded moisture from his brow.

"My main crop?" he repeated. "I think this year it's weeds!"

Weeds—gardeners have been fighting them for years. They compete with garden crops for moisture and nutrients and act as hosts for insects and diseases. And they grow "like weeds."

It's not time to toss in the hoe yet, though. Research at Michigan State University is turning up new and better ways to control weeds, in the small home garden as well as the commercial farm.

According to Dr. Alan Putnam, professor of horticulture, researchers are working on several means of weed control: herbicides, mulches, cultivation, microwaves and biological controls.

HERBICIDES

"The practicality of using herbicides in the home garden depends on the size of the garden and the crops you want to grow," Dr. Putnam says. "If your garden is a half-acre or larger, herbicides may be a very practical weed control method."

Herbicide research at MSU is aimed at finding out which weeds can be effectively controlled by which herbicides, with what crops a given chemical can safely be used and how environmental factors affect a herbicide's activity.

"Soil type, moisture and temperature influence how a chemical performs," Putnam explains.

"We are also interested in finding out how long herbicides remain in the soil and what happens to them there—whether they are broken down into nontoxic chemicals or hang around unchanged for a long time," he adds.

ACTIVATED CHARCOAL

—an antidote for herbicides

MSU research on using activated charcoal as an antidote to herbicides may make chemical weed control more practical for the home gardener, Putnam notes.

"Activated charcoal is a chemical that will absorb or tie up many herbicides," he explains. "When applied to the soil in the area next to the seeds or transplants, it can protect against damage by the herbicides."

In this way, chemical weed control can perhaps be used around plants where herbicides could not be used before. Though it sounds simple enough, it will take some time for this technique to become accepted, Putnam warns. Herbicides must be registered with the Environmental Protection Agency before they can be used on crops, and this lengthy process will have to be completed for each herbicide and crop combination where activated charcoal would be used in the home garden.

MULCH

Research on mulches at MSU has focused on both clear and black plastic. Black plastic effectively controls weeds by cutting out the light available to the young seedlings. Clear plastic does not control weeds but makes crops grow faster. Weed killers are put under the plastic. Mulches also conserve soil moisture, improve soil structure, enhance the appearance of your garden and keep crops cleaner.

Seeds can be planted and vegetables transplanted into the soil through slits in the plastic. Additional holes to permit water to enter the soil must be made if the plastic sheets are wider than three feet.

CULTIVATION

Research on the germination of weed seeds led MSU scientists to conclude that shallow, infrequent cultivation yields the best results, Putnam says.

"Deep cultivation may damage plant roots," he points out. "It also tends to bring deeply buried weed seeds to the soil surface where they will sprout."

You can hand-pull weeds when they're small—under two inches—if your garden is small enough to make it practical, he advises. Or use a hoe or hand trowel to chop weeds from their roots just below the soil surface. (See illustration)

MICROWAVES

Research on microwaves to control weeds, nematodes, insects and diseases is only in the beginning stages but shows real promise as an alternative to chemical controls, Putnam says.

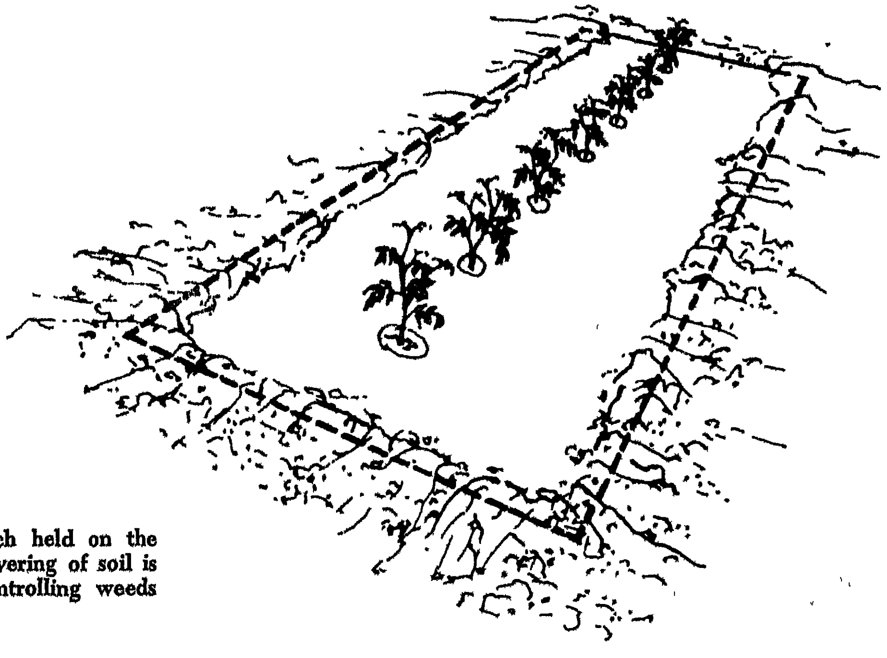
"We know that treating the soil with microwaves will kill weed seeds," he says. "The problem now is to find a practical way to treat the soil on a large scale and to determine how long a treatment is needed."

Until methods and equipment are worked out, home gardeners will have to be satisfied with using their microwave ovens to sterilize small amounts of soil for growing houseplants and starting seeds indoors. Using sterile soil should eliminate many of the problems that plague plants started indoors from seed, he notes.

BIOLOGICAL CONTROLS

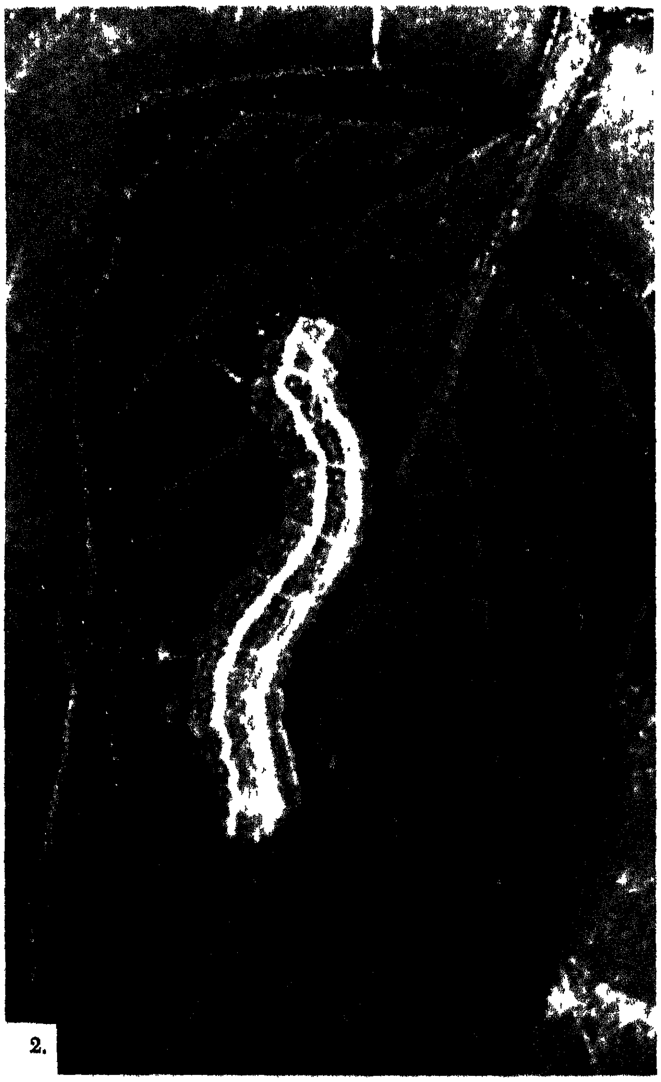
While working at Cornell University, Dr. Putnam discovered a line of cucumbers that is very effective in inhibiting weed growth. The plants release a toxic substance that suppresses weed seedlings nearby, Putnam explains. Work is continuing on this approach with the idea of developing crop plants that will compete with weeds.

"The catch now is to show that the things are fit for human consumption," he says. "Even if they are good to eat, will people grow a toxic cucumber? That'll be the next question."



Plastic or paper mulch held on the edges with a light covering of soil is very effective for controlling weeds in vegetable gardens.

1.


2.

3.

1. Root maggot inflicts serious damage to cole crops.

2. The cabbage looper can be controlled by a variety of pesticides.

3. These moths are the adult form of cabbage looper, a destructive pest.

Beat the Bugs

Home food gardeners have a better chance in the battle against the bugs, thanks to research at Michigan State University.

"Most popular vegetables have at least one pest that can ruin them," says Dr. Don Cress, Extension entomologist, "and one or more chemicals are registered for use in controlling that pest. What we try to do here is find out which chemicals work best under Michigan conditions and when is the best time to spray for maximum effect.

"When a county Extension agent advises you to use malathion, diazinon or Sevin to control cabbage loopers and imported cabbage worms, you can be sure that extensive tests have shown these chemicals are both effective and safe when properly used," says Dr. Cress.

Deciding when is the best time to spray for a particular pest can get a little complicated.

"Many garden pests overwinter in the soil and emerge in the spring to begin laying eggs for a new generation or they start feeding and damaging your seedlings or transplants," Dr. Cress says. "Others migrate in later as adults. With traps and a statewide monitoring system, we try to pinpoint the best times to plant or spray a crop to minimize the damage."

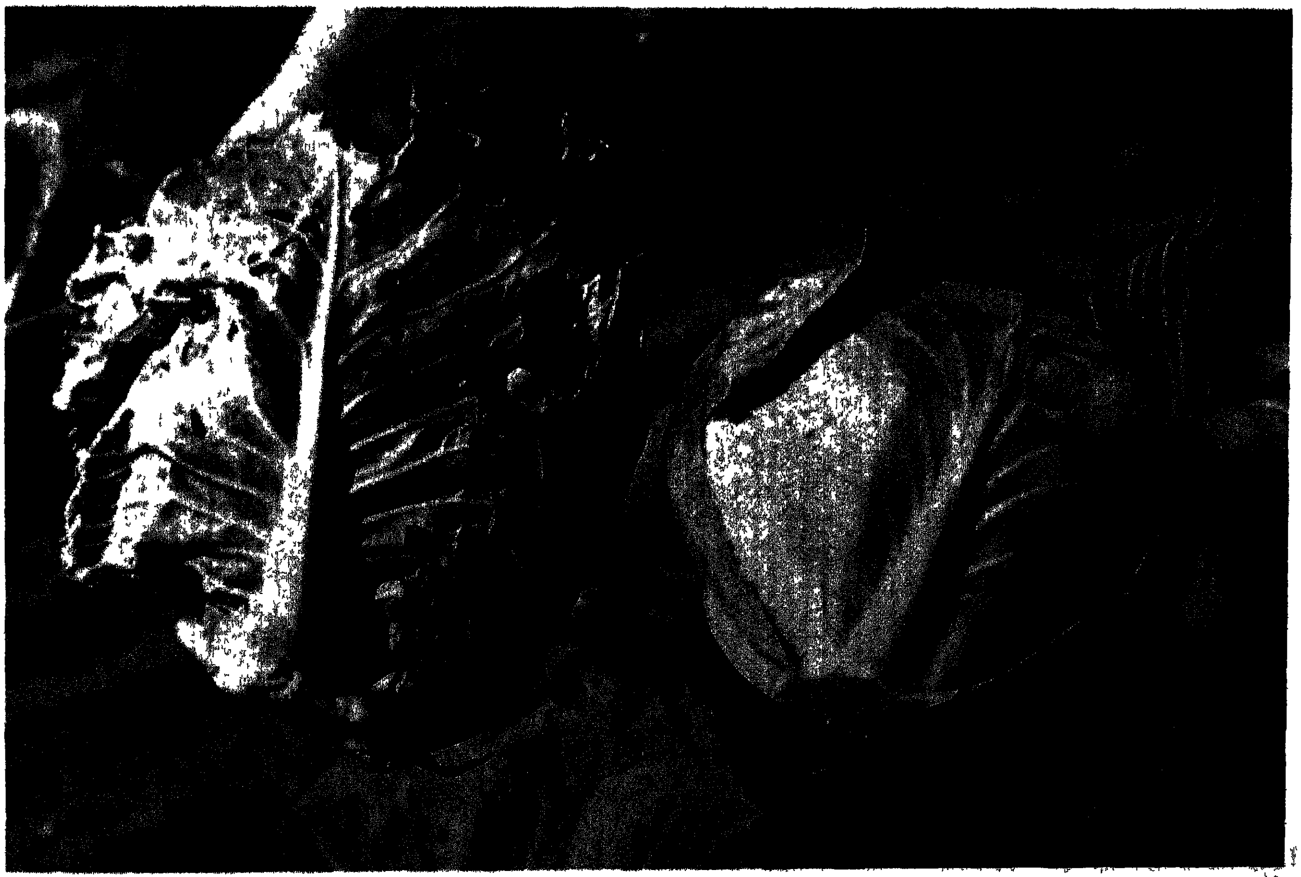
The root maggot, for example, inflicts serious damage on onions, turnips, rutabagas, cabbage and other cole crops. Traps catch the adult flies as they emerge from the soil in the spring and begin to lay eggs. Emergence data are correlated with information on soil and air temperatures to help researchers predict the appearance of the second and third generations. They can then tell growers when to plant certain crops to avoid the maggots and when to spray for most effective control.

Black light traps located around the state monitor adult populations of the corn earworm, European corn borer, cabbage looper, cutworms and many other damaging pests. The insects caught in these traps, which are usually run by 4-H youths or cooperating farmers, are sent to the Department of Entomology at MSU for identification.

Based on the numbers and types of pests found in the traps, entomologists alert county Extension agents to current and potential pest problems and suggest when and how to control the insects. The agents then pass the information along to growers.

"The key to control of many garden pests is catching them before the population builds up and gets out of hand," Cress says. "If we can do this with our monitoring system and pest alerts, we will be helping both home gardeners and commercial growers get better yields and cut down on the amount of spraying they have to do."

Research on insect control has not been limited to chemical controls, Dr. Cress adds. Tests have also been conducted on the use of **Bacillus thuringiensis**, a bacterial disease, which researchers have found to be an effective control for cabbage loopers, imported cabbage worms and tomato fruitworms. Research is also being done with parasites, predators and virus diseases of insects.



Cabbage on the left has been damaged by the cabbage looper.

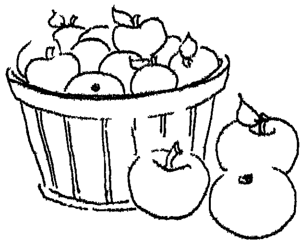
What's the Best Apple Picking Time?

Important keys to a long storage life for your home-grown apples are picking them at just the right time and storing them as close to 32 degrees F. as possible. Scientists at MSU have developed a monitoring system to pinpoint that "just right" picking time for a number of varieties and areas of the state.

The system was developed for commercial growers, says Dr. D. H. Dewey, professor of horticulture, but the information can be just as valuable to the home fruit grower.

The best time to pick apples may vary a week or more from year to year, Dr. Dewey explains. It depends on the time of bloom of the trees and the daily temperature during the first month after bloom. A cool spring will mean a later picking date; a warm spring will mean apples mature somewhat earlier. MSU scientists monitor these data and predict the best picking dates for long-term storage.

"The apple that's ready to eat when it comes off the tree is too ripe to keep well," Dr. Dewey says. "The apple that's picked before it is truly mature, on the other hand, will be subject to quick shriveling and drying out and browning of the skin. Apples picked at the proper time and stored as close to 32 degrees F. as possible will maintain high quality under storage for a long while."



Research on Ethylene Yields Storage Tips

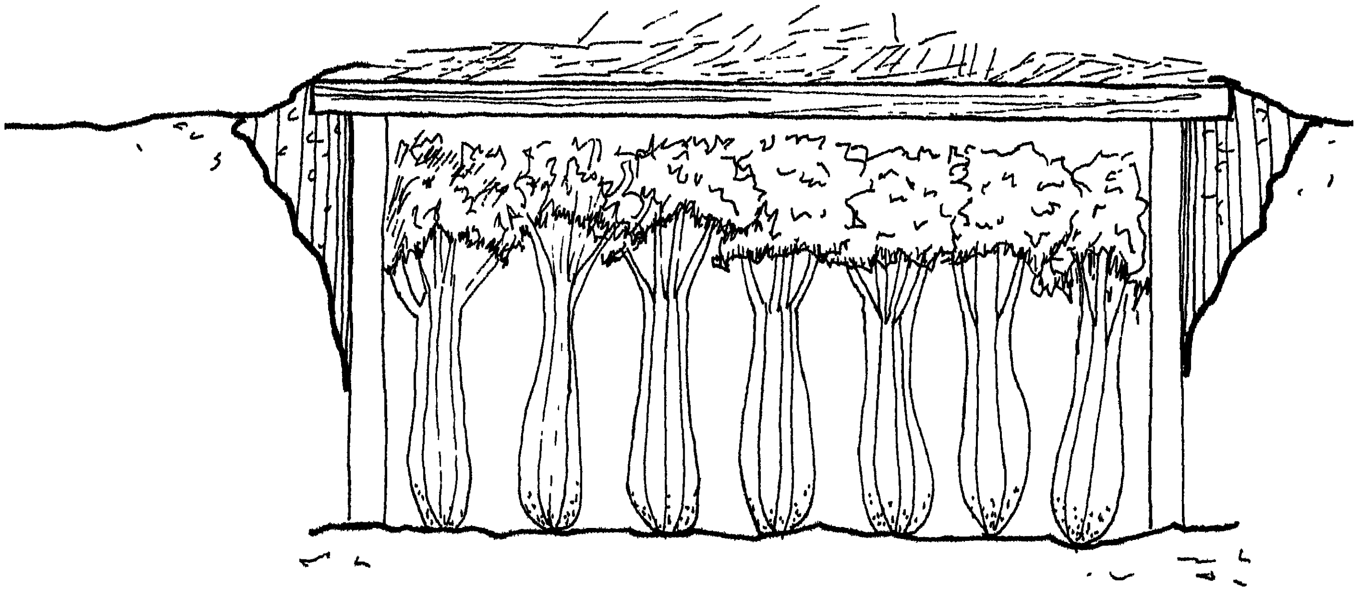
The seeds were planted, the plants grew, they bore fruit and the harvest is in. Now, whether you're a commercial grower with thousands of acres or a backyard gardener with a lot less, the problem is proper storage of your crops.

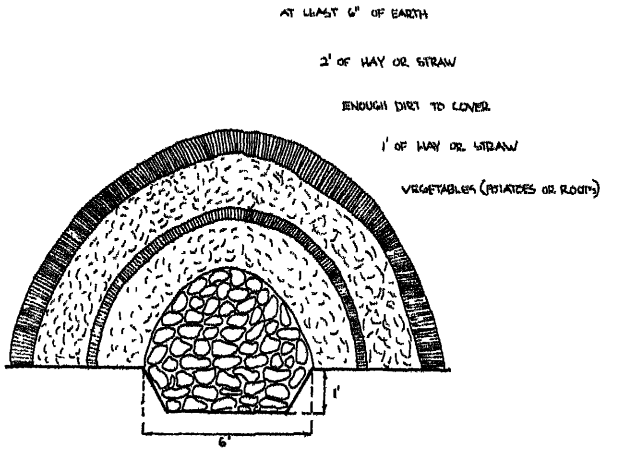
Research at MSU on post-harvest handling and storage has focused primarily on the commercial grower, and some of the methods developed at MSU are not practical for the home gardener, says Robert Herner, associate professor of horticulture. But information from studies of how fruits and vegetables ripen and deteriorate can help the home gardener make the most of his storage options.

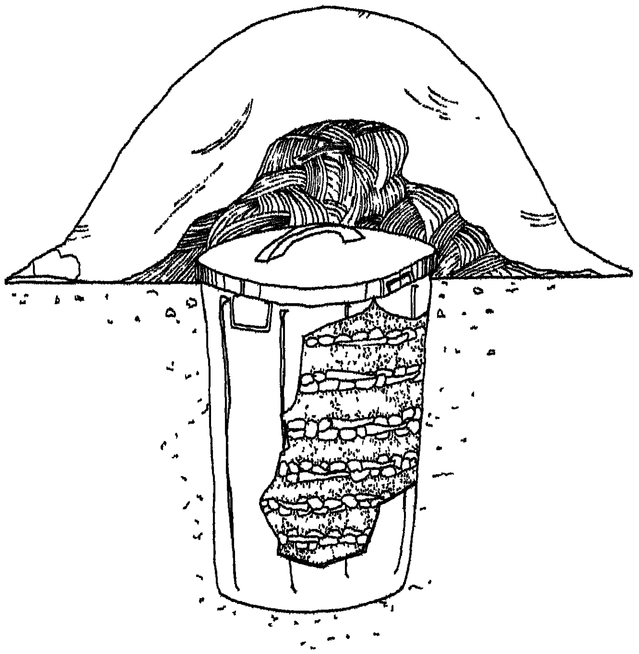
"The key factor in ripening is ethylene," Dr. Herner explains. "All plant tissues produce this gas. Especially large quantities are produced by tomatoes, apples, pears, melons and other fruit. Ethylene is a factor in storage because it speeds up the ripening process—it triggers the softening and changes in flavor, aroma and color that we associate with ripeness. If you can keep the ethylene content of the atmosphere around your crops low, you can keep the produce from ripening so fast."

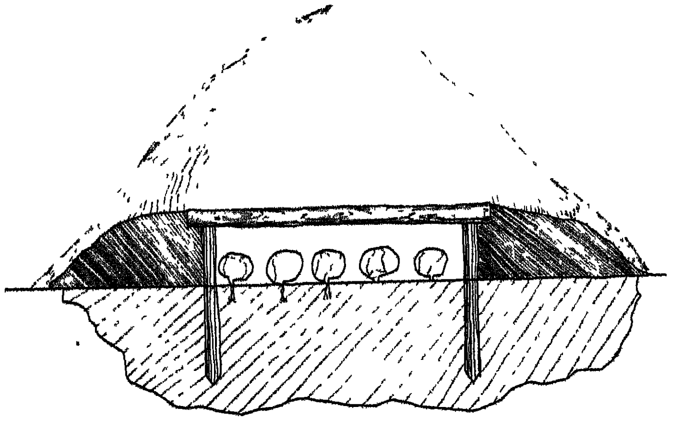
Commercial growers can use controlled atmosphere storage or store crops under refrigeration. Homeowners can reduce the effects of ethylene by storing high ethylene producers away from other crops, especially leafy vegetables and root crops. Leafy crops deteriorate quickly when exposed to ethylene, Dr. Herner points out, and root crops, especially carrots, tend to develop a bitter flavor.

"As spin-offs of ethylene research, scientists have found that you can force a bromeliad to bloom by putting it in a plastic bag with an apple," Dr. Herner notes. Bromeliads are a family of plants that includes the pineapple. "Ethylene produced by the apple stimulates the plant to bloom. You can also hurry up the ripening of mangoes and avocadoes the same way."









Outdoor Storage

Place vegetables on the ground, in a hole (6 to 8 inches deep) or in a large garbage can. Pack with alternating layers of straw and vegetables as illustrated.

Section 37.20, P. L. & R.

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FIRST CLASS

This is the 28th in a series of "*Science in Action*" publications aimed at relating research developments in specific areas within Michigan State University's Agricultural Experiment Station.

In this publication, we've tried to briefly summarize some of the latest research information on home gardening. The material was compiled and written by Leslie McConkey, Department of Information Services, Michigan State University.

The following researchers contributed to the publication:

Horticulture:
H. John Carew, Shigemi Honma, James Moulton, G. Stanley Howell, Hugh Price, Jerome Hull, A. L. Kenworthy, Alan Putnam, D. H. Dewey, and Robert Herner.

Crop and Soil Sciences:
Darryl Warncke

Entomology:
Donald Cress

Botany and Plant Pathology:
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